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Title:

Is there a Knowledge Translation Theory, Model or Framework Suitable for Health Technology Reassessment? Results from an International Survey

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Supplementary file 1: Full Survey

Supplementary file 2: Operational Definition of Criteria

Supplementary file 3: List of Excluded KT Theories, Models, and Frameworks and Reason of Exclusion

Abstract:

Objective: Health Technology Reassessment (HTR) is an emerging field focused on managing a technology throughout its lifecycle for optimal use. The process results in four recommendations: increase use, decrease use, no change, or complete withdrawal of the technology. However, implementation of these recommendations has been challenging. This paper explores knowledge translation (KT) theories, models and frameworks (TMFs) and their suitability for implementation of HTR recommendations.

Design: Cross-sectional Survey

Participants: Purposeful sampling of international KT and HTR experts was conducted between January and March 2019.

Methods: Sixteen full-spectrum KT TMFs were rated by the experts as "yes", "partially yes", or "no" on six criteria: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability. Consensus was determined as a rating of ≥ 70% responding "yes". Descriptive statistics and manifest content analysis was conducted on open-ended comments.

Results: Eleven HTR and 11 KT experts from Canada, US, UK, Australia, Germany, Spain, Italy and Sweden participated. Of the 16 KT TMFs, none received ≥ 70% rating . When ratings of "yes" and "partially yes" were combined, the Consolidated Framework for Implementation Research (CFIR) was considered the most suitable KT TMF by both KT and HTR experts (86%). One additional KT TMF was selected by KT experts: Knowledge to Action framework. HTR experts selected two additional KT TMFs: co-KT framework and Plan Do Study Act cycle. Experts identified three key characteristics of a KT TMF that may be important to consider: practicality, guidance on implementation, and KT TMF adaptability.

Conclusions: Despite not reaching an overall ≥70% level of consensus, experts identified four KT TMFs suitable for HTR. Users may apply these KT TMFs in the implementation of HTR recommendations. In addition, KT TMFs characteristics relevant to the field of HTR need to be explored further.

Key words: Health Technology Reassessment, Disinvestment, De-adoption, De-implementation, Theories, Models and Frameworks, Knowledge Translation, Implementation Science.

Article Summary

Strengths and Limitations of Study

- This was the first study to survey HTR and KT experts on KT TMFs that could be suitable for HTR.
- Through purposeful sampling, an international survey was conducted and experts were asked to rate KT TMFs as "yes", "partially yes", or "no" on six criteria: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability.
- Descriptive statistics on ratings and manifest content analysis was conducted on open-ended comments.
- The sample size of international KT and HTR experts was small to generate ≥70% level of consensus on which KT TMFs may be suitable for HTR.

Background

Health Technology Reassessment (HTR) is the systematic process of evaluating technologies that are currently in the system to ensure that they are being used optimally (1). Recommendations from the HTR process can result in the increase use, decrease use, no change, or complete withdrawal of the technology (2). However, implementation of these recommendations has been challenging (2). It has been argued that the field of knowledge translation (KT) could play a role in the implementation process for HTR recommendations (3). KT has been described as "a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of [populations], provide more effective health services and products, and strengthen the healthcare system" (4). KT can be seen as complimentary to the HTR process, but there has been a paucity of research in this area (3). Moreover, there is a gap in our understanding of which KT theories, models, or frameworks (KT TMFs hereafter) would be best suited for the translation of HTR recommendations (3).

Reviews have reported from 51 to 159 KT TMFs depending on how they are identified and considered (5-8). KT TMFs have been used in different contexts, settings, and populations (5-8). Moreover, there has been some use of the KT interventions, strategies, and TMFs to decrease or remove low value care (9, 10). These KT TMFs have been used to help identify determinants, barriers and enablers to behaviour change related to HTR (11, 12). However, the use of these KT TMFs has not been applied consistently to the development of KT interventions or the field

of HTR (3, 13). There are also no recommendations about which KT TMFs could be used. Through an international survey of KT and HTR experts, this study aims to provide an understanding of which KT TMFs could be appropriate for the HTR process and implementation of its recommendations.

Methods

This study used three approaches to the selection of KT TMFs for HTR: identification of suitable KT TMFs, consensus on the list of KT TMFs through a modified Delphi process, and selection of potentially suitable KT TMFs through a survey of international KT and HTR experts. Ethics approval was obtained from the University of Calgary's Conjoint Health Research Ethics Board [REB#17-0932].

Identification of Suitable KT TMFs

Only full-spectrum KT TMFs were included. "Full-spectrum" includes all four KT phases: planning/design, implementation, evaluation, and sustainability/scalability (8). These four KT phases are critical to the KT process and are thought to be necessary for the HTR process and implementation of its recommendations (3). A recent scoping review provided a preliminary list of 26 full-spectrum KT TMFs within cancer and chronic disease management contexts (8). A

recent update resulted in 36 full-spectrum KT TMFs identified (14). Eighteen were process models, eight were classic theories, three were determinant frameworks, three were evaluation frameworks, and four fit more than one approach category (14). This list of 36 full-spectrum KT TMFs provided the initial list of KT TMFs to assess for use when implementing HTR recommendations.

Modified Delphi Process

A three-round modified Delphi process was undertaken (15-17). The Delphi process is iterative and used to determine expert group consensus where there is a lack of evidence and expert opinion is important (18). The expert committee was composed of two HTR and three KT experts. The first and second rounds involved independent review of each KT TMF to determine which would be suitable for HTR. Each member rated the KT TMF as "yes" , "potentially yes", or "no" for HTR suitability. Consensus to keep the KT TMF was defined as 100% of the members rating the KT TMF as "yes" and/or "potentially yes". Consensus to eliminate the KT TMF was defined as 100% of the members rating the KT TMF as 'no" and/or 'potentially no'. Any KT TMFs that did not reach consensus were discussed in subsequent rounds. The third round entailed a two-hour face-to-face meeting held in October 2018. Prior to the discussion at this meeting, committee members agreed on ground rules, principles, and criteria for selection of KT TMFs for HTR suitability (Table 1). Committee members deliberated on the remaining KT TMFs until consensus was reached. Verbal consent to participate was obtained prior and the meeting was recorded.

International Expert Survey

Selection of Experts to Review KT TMFs for HTR

HTR and KT experts were selected through purposive and snowball sampling. Names were initially derived through the KT Canada website, Health Technology Assessment international (HTAi) Disinvestment Interest group, authors of relevant publications, and in consultation with other experts. A list of HTR and KT international experts was generated by country including Canada, US, UK, Australia, and European countries (Germany, Italy, Sweden, Spain). Experts were contacted via email to participate in the study. They were sent an email, invitation letter, and information sheet. If they agreed to participate, they were sent a consent form, a survey with the list of KT TMFs identified by the Delphi process to rate (Supplementary file 1), and recent article on the topic as background information (3). If they were unable to participate, the next expert name on the list was contacted. This was done to ensure that there were at least two HTR and two KT experts from each of Canada, US, UK, Australia and four HTR and four KT experts from other European countries for a target sample size of 24. Experts contacted could also suggest additional names of experts to be surveyed through snowball sampling. These names were added to the list of experts and contacted, if required, to reach a representative sample.

Survey Development

The Enhancing The Quality and Transparency of Health Research (EQUATOR) good practice in the conduct and reporting of survey research guidelines were followed for the development of the survey (19). The survey included the list of KT TMFs, a description of each KT TMF, followed by a link to the paper that described the KT TMF, if one was available. Specific criteria used previously to select KT TMFs were used to rate each KT TMF (20). These included: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability. Each criteria was operationally defined and reviewed by FC and HMH (Supplementary file 2). There was also a section for open-ended comments. The survey was developed in Excel and pilot tested by four participants to ensure flow and functionality.

Survey Administration

The survey was administered via email to the experts starting in January 2019. Based on the criteria, each KT TMF was rated by each expert as "yes", "partially yes" or "no' and additional comments could be provided. Experts were also asked to suggest additional full-spectrum KT TMFs that could be suitable for HTR and recommend other experts that could be contacted for the study. Consensus was determined as $\geq$ 70% experts selected "yes" for the particular KT TMF. The principles and criteria described in Table 1 were also shared with the international experts for information purposes. Experts were asked to return the survey within two weeks. Two additional reminders were sent. If surveys were not returned, then another expert on the list

was contacted to participate in the study. The survey was sent out to experts until March 31, 2019 to ensure that at least two HTR and two KT experts had agreed to complete the survey from the identified countries.

Data Analysis

Modified Delphi Process

After rounds 1 and 2 of the modified Delphi process, data were analyzed descriptively by tabulating the "yes", "potentially yes", and "no" responses for HTR suitability for each KT TMF reviewed by the expert committee members.

Survey Data

Survey data were analyzed descriptively by tabulating the "yes", "partially yes", and "no" responses for HTR suitability for each KT TMF and by HTR and KT expert sub-groups. KT TMF familiarity and missing data were also descriptively summarized.

Data from the open-ended comments section of the survey provided by the HTR and KT experts was analyzed using content analysis (21). As these data were limited in volume, content analysis was undertaken to provide a starting point in determining preliminary factors that may be important to consider for a KT TMF for HTR.

Initially, all comments from each expert were entered into Excel and categorized by KT TMF. These were read and reread to get familiarized with the data. Next, for each KT TMF, each comment was organized by response to HTR suitability as "yes", "partially yes", "no", and unfamiliar with the KT TMF. This categorization provided an understanding of what comments may or may not be important to consider for HTR suitability. Open coding and constant comparison were applied inductively to all the comments. A preliminary list of codes, sub-codes, and operational definitions were developed manually through independent review of the comments from three KT TMFs (Consolidated Framework for Implementation Research (CFIR), Stages of Research Evaluation, and Knowledge to Action (KTA) framework) by RE and HMH. A final taxonomy consisting of codes, sub-codes, operational definitions, and exemplar quotes was applied manually to the comments for the remaining KT TMFs by RE (Box 1). Manifest content analysis, defined as the development of categories as opposed to latent content analysis (defined as the development of themes), was determined to be best suited given the nature of the open-ended comments (21). Therefore, categories were created, grouping codes under higher order headings, and formulating a general description of these categories. In addition, the frequency of comments for each code in each category was also tabulated by HTR and KT expert to determine the top categories/codes. The most prominent codes and interpretation of the data were then determined through the frequency counts, discussion and consensus among FC and HMH.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Results

Modified Delphi Process

The results of the modified Delphi process are presented in Table 2. The third round resulted in the selection of 16 full-spectrum KT TMFs. There were 12 process models, two frameworks, one classic theory, and one KT TMF that fit two categories (model and framework). Twenty KT TMFs were excluded. Fourteen were too vague and not descriptive enough, two were considered 'passive' and not 'active' KT TMFs to make change happen, two were not pragmatic, and two were too specific to a given context (i.e. guideline adaptation and disability research) (Supplementary file 3).

International Expert Survey

Forty-eight KT experts and 31 HTR experts were invited to participate via email. A total of 22 experts (11 KT and 11 HTR) completed the survey. Experts were from Canada (4), US (5), UK (4), Australia (4), Germany (2), Spain (1), Italy (1), and Sweden (1). Fifty-nine percent were women, and all had graduate-level education (Masters or PhD).

Overall, of the 16 KT TMFs none received a "yes" rating for HTR suitability by ≥ 70% of the experts. The top three most highly rated KT TMFs were CFIR (22), KTA (23) and the Plan-Do-

Study-Act (PDSA) cycle (24). Thirty-eight percent of the experts rated CFIR as "yes", followed by 27% each for the KTA framework and the PDSA cycle (24). The least rated KT TMFs by the experts were the KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (25), the Stages of Research Evaluation (26), the Staged Model of Innovation Development and Diffusion of Health Promotion Programs (27) that all received 0% ratings for "yes" by the experts (Figure 1). Combination of the "yes" or 'partially yes' ratings found that 86% (19/22) of the experts selected CFIR as the top rated KT TMF for HTR suitability (22).

Stratified analysis by KT and HTR Expertise

KT experts favored KTA (82%, 9/11) as another KT TMF that would be suitable for HTR (23) in addition to CFIR (91%, 10/11). The HTR experts favored the Co-KT Framework (72%, 8/11) (28) and the PDSA cycle (72%, 8/11) (24) in addition to CFIR (82%, 9/11).

Content Analysis

Forty-nine percent of the comments provided by both KT and HTR experts were related to the TMF characteristics category, followed by the TMF attributes category (19%). Implementation and user categories both had 13% each (Figure 2).

Overall, the top code was pragmatic under the TMF characteristics category (14%) defined as the KT TMF not being theoretical but practical and application of the TMF outside of research or

academic settings. This was followed by implementation (13%), defined as the KT TMF provides operation detail on how to 'do' the implementation to achieve the HTR outputs. This also included exploring determinants, their inter-relationships, and the development of interventions or strategies based on these determinants. The third top code was HTR suitability under the TMF attributes category (8%), defined as a 'strong fit' to HTR and its determinants. It also included the ability to adapt the KT TMF and tailor it to micro (individual), meso (organizational) and macro (policy) levels (3).

More KT experts than HTR experts commented on pragmatic as an important characteristic for a KT TMF (56% versus 44%). There were both positive and negative comments related to pragmatic for a KT TMF that would make it suitable for HTR. For example, one KT expert who said "yes" to HTR suitability for the PDSA cycle noted the following positive affect:

> "A basic, simple but still very useful approach" [009].

In contrast, in reference to the Stages of Research Evaluation, one HTR expert who said 'no" to HTR suitability stated the following negative affect:

> "This is also difficult to be implemented in reality as it is far from explaining the characteristics of the healthcare systems and professional interactions" [017].

More KT experts than HTR experts provided comments related to implementation (78% versus 22%). There were both positive and negative affects of comments related to implementation for a KT TMF that would make it suitable for HTR. One KT expert who said "yes" to HTR suitability for the Quality Implementation framework stated the following positive affect:

> "I'm not familiar with specifics about this framework; it certainly covers the full-spectrum of considerations for implementing new interventions; could be adapted for de-adoption/implementation "[005].

On the contrary, another KT expert who said 'no" to HTR suitability with respect to Diffusion of Innovation theory stated the following negative affect:

> "I think (as it is a general theory rather than an implementation framework/model) that it lacks sufficient guidance on how to implement/de-implement" [007].

More KT experts provided comments to HTR suitability than HTR experts (60% versus 40%). There were both positive and negative affects of comments related to HTR suitability for a KT TMF. One HTR expert who said partially "yes" to HTR suitability for CFIR stated the following positive affect:

> "A lot of constructs have been included in CFIR, so in each case, it would probably require selection of the specific ones relevant for the HTR example" [021].

Whereas another KT expert who said 'no" to HTR suitability for the CollaboraKTion framework stated:

> "Depends on focus of work-this emphasizes need for community to decide on action whereas if you had a particular output in mind to implement/de-implement this might not be the best fit" [001].

However, HTR experts commented more on the ability to tailor the KT TMF to micro, meso, macro levels than KT experts (90% versus 10%).

Discussion

Key Findings

The focus of this study was to determine KT TMFs that could be suitable for implementation of HTR recommendations. Three key findings emerged: 1) ≥ 70% consensus (rated as "yes" by the experts) was not reached by the international KT and HTR experts on any of the full-spectrum KT TMFs; however when ratings of "yes" and "partially yes" were combined, CFIR was considered the most suitable KT TMF by both KT and HTR experts; 2) KT experts identified one additional KT TMF: KTA framework, whereas HTR experts identified two additional KT TMFs: co-KT framework and PDSA cycle as potentially suitable for the implementation of HTR recommendations; and 3) Overall, experts commented on three key characteristics of a KT TMF that may be important to consider: practicality, guidance on how to implement and adaptability of the KT TMF to HTR.

Strengths

This study utilized a modified Delphi process and survey to illicit input from internal and international KT and HTR experts. Although, experts may not have sufficient knowledge of all the KT TMFs, this was the first study that attempted to garner the opinions of experts in both fields of KT and HTR. The field of KT and its application to HTR has been proposed as a mechanism to advance the implementation of HTR recommendations into practice (3). The selection of one determinant framework (CFIR), and three process models (KTA framework, co-

KT framework, and the PDSA cycle) provides a starting point of potential KT TMFs that could be used with HTR. However, as ≥ 70% consensus was not reached by the experts, these findings need to be considered as preliminary.

Limitations

The Delphi technique has been criticized for lack of guidelines on the determination of the size of the expert panel, lack of anonymity, what is meant by 'expert' opinion, and determination on the level of consensus (29). The sample size of five for the internal committee may have been too small to review and select KT TMFs from the list of 36 full-spectrum KT TMFs. The 100% consensus level may have been too high. There may also have been pressures of conformity at the face-to-face meeting. However, there was a wide-range of expertise within the internal committee including two physicians, health economist, epidemiologist, and social scientist all with backgrounds in HTR, KT or both. The use of a facilitator and establishment of ground rules, and principles upfront were important considerations to address pressures of conformity.

Although purposeful sampling was used for the survey, the sample size of international KT and HTR experts was small which may have reduced the ability to generate consensus. Both the KT and HTR communities are relatively new and small. Therefore, there is a limit to the pool of experts one can select from. However, a wide net was cast to recruit experts and efforts were also made to ensure a representative sample from different jurisdictions and depth and breadth of knowledge in both KT and HTR. Lastly, the selection of 70% consensus was arbitrary and determined a priori to survey administration. This level of agreement has been considered appropriate in previous Delphi studies (30), but there is no acceptable level of consensus (29).

Implications of Findings

Among the list of 16 full-spectrum KT TMFs identified through a modified Delphi process, the international experts were unable to determine a clear KT TMF for HTR. Lack of familiarity with the KT TMFs could be one reason. Specifically, experts were not familiar enough with four of the 16 KT TMFs to rate them for HTR suitability. Over recent years, there has been a flurry of KT TMFs developed (8). This proliferation of KT TMFs makes it challenging for experts to keep abreast of them all. Moreover, there has been criticism of the development of KT TMFs without adequate testing, validation and research (31). Experts within the KT field may lean towards those KT TMFs that they are most familiar with (8).

Another reason experts were challenged to select a KT TMF could have been due to the lack of understanding of the HTR process. KT experts in particular, may have found it difficult to review the KT TMFs and then apply them to HTR, as they may not be familiar enough with the HTR process itself. HTR is a relatively new field and has been confused with terms such as 'disinvestment' and 'de-adoption', which are considered outcomes of the HTR process rather than the process itself (2). In addition, the field of HTR is under-developed and concepts have yet to be agreed upon (3). An information sheet and background paper with a description of the fields of KT and HTR was provided to the experts prior to the survey. However, these materials may not have been reviewed in advance or been a sufficient knowledge resource.

CFIR was the only KT TMF selected by both HTR and KT experts as a potential KT TMF that could be used for HTR. CFIR has been used widely and is a well-operationalized, multi-level implementation determinant framework derived from theory (32, 33). The application of CFIR and its constructs may enable users to assess facilitators and barriers to the implementation of HTR recommendations, particularly when HTR recommendations result in decrease use or removal of the technology. The assessment of facilitators and barriers has been noted as an important step within the de-adoption process of low value care (3, 34). However, studies that apply CFIR to HTR projects are required to provide further understanding of its application.

The KTA framework was primarily selected as suitable for HTR by KT experts. Its selection could be due to its wide-spread use in the KT field (35, 36). In fact, one adaptation of the KTA framework has been the Synthesis Framework for Facilitating De-adoption (34). This framework has been proposed as one that could be used for potential HTR projects (3). However, it has yet to be applied in practice for HTR. Nonetheless, the KTA framework's ability to be adaptable may be another factor as to its selection primarily by KT experts.

The co-KT framework (28) and PDSA cycle (24) were primarily selected for HTR suitability by HTR experts. Both are process models (14). The co-KT framework is a linear process and may be considered simplistic to apply. The PDSA cycle has been used extensively in quality improvement as a model for change (37). It is a simple and pragmatic model to use and is adaptable within other models (38). However, it is not without its limitations (37). Subsequently, selection of these KT TMFs by HTR experts may be due their ease of use.

Implications for Future Research

Although not the key focus of this study, three key characteristics: practicality, guidance on how to implement; and adaptability of the KT TMF to HTR were identified from the open-ended comments. Characteristics that may considered as important in a KT TMF for HTR use need to be investigated further. Moreover, future research on identifying these characteristics through expert interviews is needed to better understand which would influence and demonstrate an important role within the process of HTR.

Recently, there has also been a proliferation of disinvestment frameworks or frameworks to address overuse (13, 39, 40). Some are based on KT and Implementation Science principles (13). The focus of these frameworks has been on removing or reducing low value care from practice. The application of these frameworks is still in its infancy. Although, the list of full-spectrum KT TMFs that were examined in this study did not consider these disinvestment frameworks, there may be merit in doing so. In particular, the use of these frameworks for the HTR outputs of decrease use or complete removal of a technology.

Conclusion

This study provided insights into which KT TMFs may be suitable for HTR. Despite not attaining ≥ 70% consensus on the KT TMFs, experts selected four KT TMFs that could be used within the context of HTR. Familiarity, adaptability and ease of use may be some of the reasons that led to their selection. Moreover, characteristics of practicality, how to implement HTR recommendations, and adaptability of the KT TMF to HTR need to be interrogated to determine if they are important in a KT TMF for HTR. The process of HTR could vastly benefit from the field of KT and its application of KT TMFs in implementation of its recommendations. A better understanding and awareness of the application of KT to the field of HTR will provide much needed guidance and advancement in this area.

Competing Interests: None

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Contributors: Rosmin Esmail conducted the study, collected and analyzed the data. Rosmin Esmail, Fiona Clement and Heather Hanson drafted the manuscript. All the authors contributed to the study conception and design, data interpretation, were involved in revising the manuscript for important intellectual content. All authors read and approved the final manuscript.

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Table 1: List of Criteria Developed by Expert Committee Members for Round 3 of Modified Delphi Process

Criteria
The final list of KT TMFs must have face validity (KT TMFs that are common and well-known should be included)
The KT TMFs must be active KT TMFs (passive KT TMFs were excluded)
The KT TMF must be feasible to apply to take something out of practice
The KT TMF was pragmatic (theoretical KT TMFs were excluded)
The KT TMF must be specific (vague or those that were not prescriptive were excluded)
The KT TMF could build on other KT TMFs but needed to be generic rather than for a specific context
The KT TMF is easily understood and practical
Any KT TMF that the committee was undecided on

Box 1: Taxonomy of Codes and Sub-codes for Comments

Implementation	TMF Characteristics	TMF Attributes	User	Survey Logistics/General Comments
Codes in a KT TMF related to implementation of HTR	Codes related to elements or components in a KT TMF for HTR	Code that are considered foundational in a KT TMF for to HTR	Codes related to the use of TMFs for HTR from a user perspective	Codes related to the process of survey administration or extraneous

• Implementation
  ○ Development of intervention or strategies
  ○ Inter-related determinants
	• Pragmatic real world application
	• Straightforward
	• Engagement of relevant (patient, public, clinician) stakeholders
	  ○ Synchronicity
	• Lack specificity/insufficient details
	• Complexity
	• Prioritization of HTR
	• Resources such as economic, evidence, funding, local factors.
	  ○ Additional support
	• Adaptation
	  ○ Additional TMFs
	• Sustainability
	• Evaluation
	• Influential
	  ○ Originality (face validity)
		• HTR Suitability
		• Consideration of alternatives
		• Ability to tailor or applicability micro/meso/macro levels
		• Centrality evidence
		• Contextual fit
		• Motivation
		  ○ Challenge of removing something (feasible to apply -take something out of practice)
		• Values
		• Generalizability
		• Not a KT TMF
			• Familiarity
			• Access
			• Use by novices
				• Survey process/method oriented
				• Non-dated data

Table 2: Summary Results of KT Theories, Models and Frameworks Included and Excluded from Rounds 1 to 3 of the Modified Delphi Process

Included in Round 1	Excluded in Round 1
Consolidated Framework for Implementation Research (CFIR) (Damschroder, 2009)	A conceptual framework for planning and improving evidence-based practices (Spencer, 2013)
Stages of research evaluation (Nutbeam, 2006)	Interorganizational Relations Theory (Steckler, 2002)
Knowledge-to-Action (KTA) (Graham, 2006)	Self-Regulation Theory (Baumeister, 2011)
Quality Implementation Framework (Meyers, 2012)	Social Cognitive Theory (SCT) (Bandura, 1991)
Western Australia (WA) Health Network Policy Development and Implementation Cycle (Briggs, 2012)	Social Ecology Model for Health Promotion (Stokols, 1992)
	Transtheoretical Model of Behaviour Change (Prochaska, 1997)
Included in Round 2	**Excluded in Round 2**
Collaborative model for achieving breakthrough improvement (Institute for Healthcare Improvement, 2003)	LEAN transformation process (Lean Enterprise, 2011)
Included in Round 3	**Excluded in Round 3**
Diffusion of Innovations (Rogers, 1983)	NCHPAD (National Center on Health, Physical Activity and Disability) Knowledge, Adaptation, Translation and Scale-up (N-KTAS) Framework (Rimmer, 2016)
Healthcare Improvement Collaborative Model (Edward, 2017)	Community Connection model (Liddy, 2013)
Co-KT framework (Kitson, 2013)	Model for accelerating improvement (Associates in Process Improvement Langley, 2009)
Plan-do-study-act cycle (Deming, 1986)	Social marketing framework (National Excellence Collaborative, 2003)
A staged model of innovation development and diffusion of health promotion programs (Oldenburg, 1996)	Community-based Knowledge Translation framework (Campbell, 2010)
Evidence-driven community health improvement process (EDCHIP) (Layde, 2012)	Knowledge integration process (Glasgow, 2012)
RE-AIM (Glasgow, 1999)	Precaution Adoption Process model (Weinstein, 2008)
CollaboraKTion framework (Jenkins, 2016)	Social learning theory (Bandura, 1952)
KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (Nieva, 2005)	CAN-IMPLEMENT (Harrison, 2018)

Design focused implementation model (Ramaswamy, 2018)	The translational model of the Black Dog Institute (Werner-Seidler, 2016)
	PRECEDE-PROCEED (Green, 2005)
	Community to community mentoring model (Liddy, 2013)
	Stage theory of organization change (Butterfoss, 2008)
Total Included=16	**Total Excluded=20**

Figure 1: HTR Suitability of KT Theories, Models, Frameworks (TMF) by all Experts

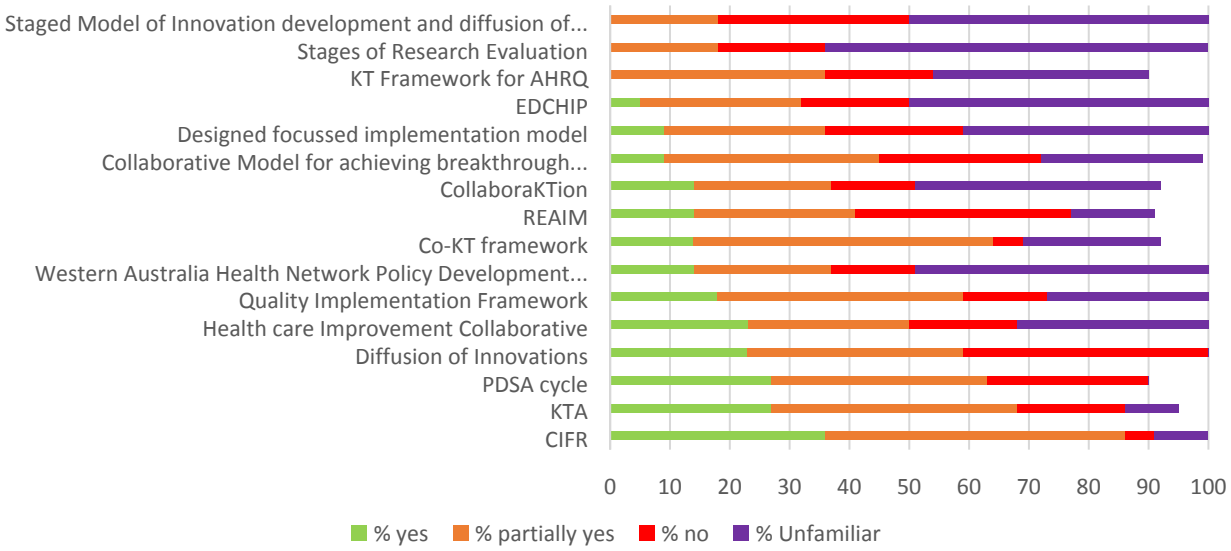
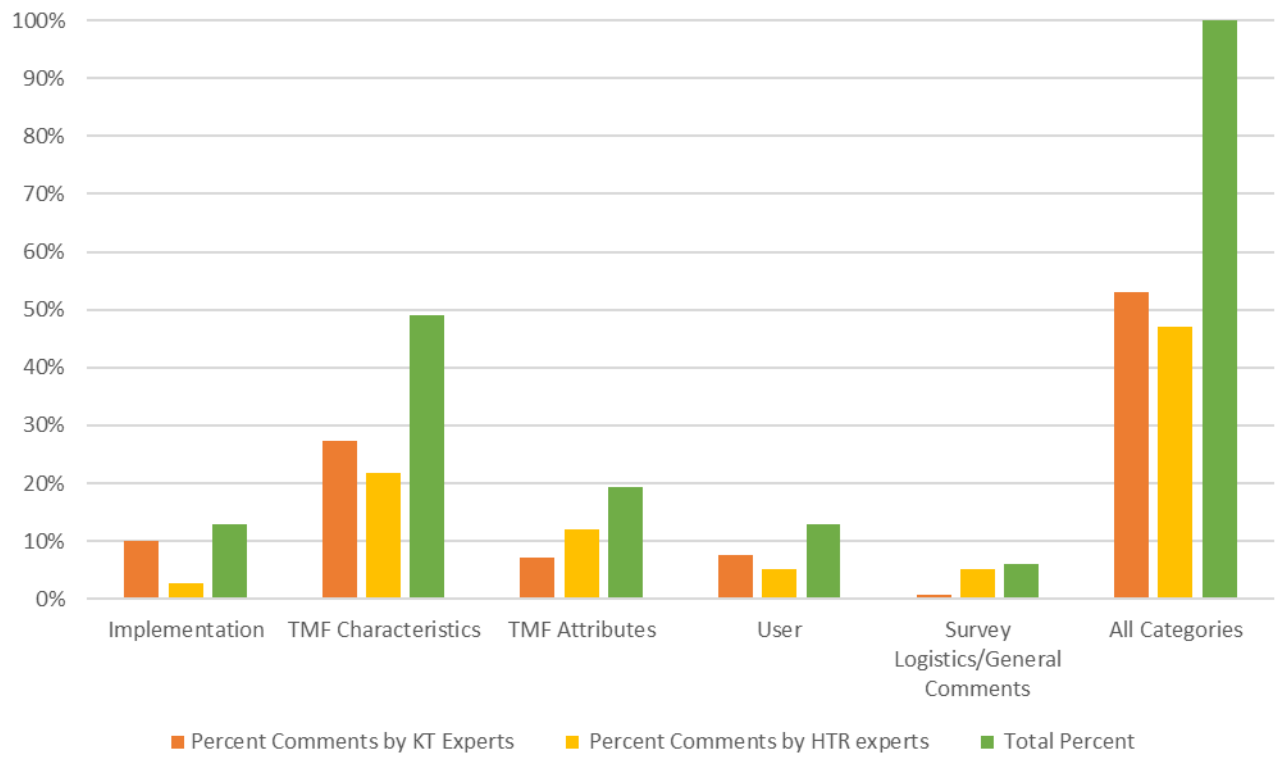


Figure 2: Total Comments for Each Category Provided by KT and HTR Experts



Instructions:

Dear Expert, there are 16 full-spectrum KT theories, models and frameworks to review in column A. A brief description of each KT theory, model, framework is provided through a comment box (red triangle in corner of the cell) and a link to the paper, if available, in column B. For each full-spectrum Knowledge Translation (KT) theory, model or framework please review each criteria in sheet #1 columns C to G and rate as yes,
In sheet #1, based on your responses to columns C to G, please determine if that KT theory, model or framework is suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology) and indicate your response as yes, partially yes, or no using the drop box menu in
In sheet #1, column I, please feel free to provide any comments.
Please feel free to respond to questions in rows #18 and #19.
Please save your file and return it via email to rosmin.esmail@ucalgary.ca

Definitions:

Knowledge Translation (KT): a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products, and strengthen the healthcare system (CIHR, 2017)

Health Technology Reassessment (HTR): is a structured, evidence-based assessment of the clinical, social, ethical, and economic effects of a technology currently in use to inform its optimal use in comparison to its alternatives (Noseworthy and Clement, 2012)

Full-Spectrum: A full-spectrum KT theory, model or framework is one that that has been used in the literature by study authors to inform their KT work and guide all four KT phases: i) planning/design (identifies a knowledge gap, engages stakeholders, develops an intervention), ii) implementation, iii) evaluation, and iv) sustainability/scalability (Strifler et al, 2018)

Name of Full-Spectrum Knowledge Translation (KT) Theory, Model, Framework
Consolidated Framework for Implementation Research (CFIR) (Damschroder, 2009)
Stages of Research Evaluation (Nutbeam, 2006)
Knowledge-to-Action (KTA) (Graham, 2006)
Quality Implementation Framework (Meyers, 2012)-link to abstract only
Western Australia (WA) Health Network Policy Development and Implementation Cycle (Briggs, 2012)
Collaborative Model for Achieving Breakthrough improvement (Institute for Healthcare Improvement, 2003)
Diffusion of Innovations (Rogers, 3rd Edition, 1983)
Healthcare Improvement Collaborative Model (Edward, 2017)
Co-KT framework (Kitson, 2013)
Plan-Do-Study-Act (PDSA) Cycles (Deming, 1986)
A Staged Model of Innovation Development and Diffusion of Health Promotion Programs (Oldenburg, 1996)-link to abstract only
Evidence-Driven Community Health Improvement Process (EDCHIP) (Layde, 2012)
Reach Effectiveness Adoption Implementation Maintenance (RE-AIM) (Glasgow, 1999)
CollaboraKTion framework (Jenkins, 2016)

KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (Nieva, 2005)
Design Focused Implementation Model (Ramaswamy, 2018)
Please feel free to identify any other full-spectrum KT theories, models, or frameworks that have been missed and could be used for HTR
Please feel free to identify names of KT or HTR experts that could be contacted for this study

Link to Published KT Theory, Model, Framework (if available)
https://www.ncbi.nlm.nih.gov/pubmed/19664226
Book-no link available
https://onlinelibrary.wiley.com/doi/abs/10.1002/chp.47 https://www.ncbi.nlm.nih.gov/pubmed/22644083
https://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-12-394
http://www.ihi.org/resources/Pages/IHIWhitePapers/TheBreakthroughSeriesIHIsCollaborativeModelforAchievingBreakthroughImprovement.aspx
https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwjjlIPX_PffAhU5HjQIHd5MDUkQFjABegQIAhAC&url=https%3A%2F%2Fteddykw2.files.wordpress.com%2F2012%2F07%2Feverett-m-rogers-diffusion-of-innovations.pdf&usg=AOvVaw3NYB0CAj1BlGacLxjbfccf
https://academic.oup.com/intqhc/article/29/5/740/4082140 https://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-8-54 https://deming.org/explore/p-d-s-a
https://search.informit.com.au/documentSummary;dn=461377669128445;res=IELAPA
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3489378/
https://www.ncbi.nlm.nih.gov/pubmed/10474547
https://www.ncbi.nlm.nih.gov/pubmed/27578195

https://www.ncbi.nlm.nih.gov/books/NBK20521/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5778695/

Familiarity-Are you familiar with the KT, theory, model or framework?

Logical Consistency/Plausibility-Does the KT theory, model or framework, include meaningful, face-valid explanations of proposed relationships?

Degree of specificity-Does the KT theory, model, or framework include constructs that are comprehensive of implementation determinants or specific to a set of implementation determinants that could be applied to health technology reassessment (HTR)?

Accessibility-Would non-experts be able to understand, apply and operationalize the KT theory, model, or framework to HTR?

Ease of use-Can the KT theory, model, or framework be used easily?

HTR Suitability-Based on your responses to the previous criteria, is the KT theory, model, framework suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology)?

Comments

Supplementary file 2: Operational Definition of Criteria

Criteria	Operational Definition
Familiarity	Are you familiar with the KT, theory, model or framework?
Logical Consistency/Plausibility	Does the KT theory, model or framework, include meaningful, face-valid explanations of proposed relationships?
Degree of specificity	Does the KT theory, model, or framework include constructs that are comprehensive of implementation determinants or specific to a set of implementation determinants that could be applied to health technology reassessment (HTR)?
Accessibility	Would non-experts be able to understand, apply and operationalize the KT theory, model, or framework to HTR?
Ease of use	Can the KT theory, model, or framework be used easily?
HTR Suitability	Based on your responses to the previous criteria, is the KT theory, model, framework suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology)?

Supplementary file 3: List of Excluded KT Theories, Models, and Frameworks and Reason of Exclusion (n=20)

KT Theories, Models and Frameworks Excluded	Too vague	Not pragmatic	Passive	Too Specific
A conceptual framework for planning and improving evidence-based practices (Spencer, 2013)	X			
Interorganizational Relations Theory (Steckler, 2002)	X			
Self-Regulation Theory (Baumeister, 2011)		X		
Social Cognitive Theory (SCT) (Bandura, 1991)			X	
Social Ecology Model for Health Promotion (Stokols, 1992)	X			
Transtheoretical Model of Behaviour Change (Prochaska, 1997)			X	
LEAN transformation process (Lean Enterprise, 2011)		X		
NCHPAD (National Center on Health, Physical Activity and Disability) Knowledge, Adaptation, Translation and Scale-up (N-KTAS) Framework (Rimmer, 2016)				X
Community Connection model (Liddy, 2013)	X			
Model for accelerating improvement (Associates in Process Improvement Langley, 2009)	X			
Social marketing framework (National Excellence Collaborative, 2003)	X			
Community based KT framework (Campbell, 2010)	X			
Knowledge integration process (Glasgow, 2012)	X			
Precaution Adoption Process model (Weinstein, 2008)	X			
Social learning theory (Bandura, 1952)	X			
CAN-IMPLEMENT (Harrison, 2018)				X (guideline focused)
The translational model of the Black Dog Institute (Werner-Seidler, 2016)	X			
PRECEDE-PROCEED (Green, 2005)	X			

KT Theories, Models and Frameworks Excluded	Too vague	Not pragmatic	Passive	Too Specific
Community to community mentoring model (Liddy, 2013)	X			
Stage theory of organization change (Butterfoss, 2008)	X			

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Identification of Knowledge Translation Theories, Models or Frameworks Suitable for Health Technology Reassessment: A Survey of International Experts

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Title:

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Supplementary file 1: Survey Instrument

Supplementary file 2: Operational Definition of Criteria

Supplementary file 3: List of Excluded KT Theories, Models, and Frameworks and Reason of Exclusion from the Modified Delphi Process

Abstract:

Objective: Health Technology Reassessment (HTR) is a field focused on managing a technology throughout its lifecycle for optimal use. The process results in one of four possible recommendations: increase use, decrease use, no change, or complete withdrawal of the technology. However, implementation of these recommendations has been challenging. This paper explores knowledge translation (KT) theories, models and frameworks (TMFs) and their suitability for implementation of HTR recommendations.

Design: Cross-sectional survey

Participants: Purposeful sampling of international KT and HTR experts was administered between January and March 2019.

Methods: Sixteen full-spectrum KT TMFs were rated by the experts as "yes", "partially yes", or "no" on six criteria: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability. Consensus was determined as a rating of ≥ 70% responding "yes". Descriptive statistics and manifest content analysis was conducted on open-ended comments.

Results: Eleven HTR and 11 KT experts from Canada, US, UK, Australia, Germany, Spain, Italy and Sweden participated. Of the 16 KT TMFs, none received ≥ 70% rating. When ratings of "yes" and "partially yes" were combined, the Consolidated Framework for Implementation Research (CFIR) was considered the most suitable KT TMF by both KT and HTR experts (86%). One additional KT TMF was selected by KT experts: Knowledge to Action framework. HTR experts selected two additional KT TMFs: co-KT framework and Plan Do Study Act cycle. Experts identified three key characteristics of a KT TMF that may be important to consider: practicality, guidance on implementation, and KT TMF adaptability.

Conclusions: Despite not reaching an overall ≥70% rating on any of the KT TMFs, experts identified four KT TMFs suitable for HTR. Users may apply these KT TMFs in the implementation of HTR recommendations. In addition, KT TMFs characteristics relevant to the field of HTR need to be explored further.

Key words: Health Technology Reassessment, Disinvestment, De-adoption, De-implementation, Theories, Models and Frameworks, Knowledge Translation, Implementation Science.

Article Summary

Strengths and Limitations of Study

- This was the first study to solicit the perspectives of international HTR and KT experts on the suitability of KT TMFs for HTR.
- Through purposeful sampling, a survey was administered to HTR and KT international experts.
- Experts were asked to rate each KT TMF as "yes", "partially yes", or "no" on six criteria: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability.
- Descriptive statistics on ratings for each KT TMF were conducted.
- Manifest content analysis was applied to open-ended comments.

Background

Health Technology Reassessment (HTR) is the systematic process of evaluating technologies that are currently in the health system to ensure that they are being used optimally (1). Recommendations from the HTR process can result in the increase use, decrease use, no change, or complete withdrawal of the technology (2). However, implementation of these recommendations has been challenging (2). It has been argued that the field of knowledge translation (KT) could play a role in the implementation process for HTR recommendations (3). KT has been described as "a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of [populations], provide more effective health services and products, and strengthen the healthcare system" (4). In essence, KT is the application of putting knowledge into practice and policy. KT approaches could be used in the HTR process to bridge the gap between the generation of recommendations regarding optimal technology use and their implementation in practice (3) Thus, KT can be seen as complimentary to the HTR process, but there has been a paucity of research in this area (3). Moreover, there is a gap in our understanding of which KT theories, models, or frameworks (KT TMFs hereafter) would be best suited for the translation of HTR recommendations (3).

In the literature, two narrative reviews and two scoping reviews have reported from 41 to 159 KT TMFs depending on how they are identified and considered (5-8). KT TMFs have been used in different contexts, settings, and populations (5-8). Moreover, there has been some use of

the KT interventions, strategies, and TMFs to decrease or remove low value care (9, 10). These KT TMFs have been used to help identify determinants, barriers and enablers to behaviour change related to HTR (11, 12). However, the use of these KT TMFs has not been applied consistently to the development of KT interventions or the field of HTR (3, 13). There are also no recommendations about which KT TMFs could be used for HTR. Through an international survey of KT and HTR experts, this study aims to provide an understanding of which KT TMFs could be appropriate for the HTR process and implementation of its recommendations.

Methods

This study used three approaches to the selection of KT TMFs for HTR: identification of suitable KT TMFs, consensus on the list of KT TMFs through a modified Delphi process, and selection of potentially suitable KT TMFs through a survey of international KT and HTR experts.

Ethics approval was obtained from the University of Calgary's Conjoint Health Research Ethics Board [REB#17-0932].

Identification of Suitable KT TMFs

Only full-spectrum KT TMFs were included. "Full-spectrum" includes all four KT phases: planning/design, implementation, evaluation, and sustainability/scalability (8). These four KT

phases are critical to the KT process and are thought to be necessary for the HTR process and implementation of its recommendations (3). A recent scoping review provided a preliminary list of 26 full-spectrum KT TMFs within cancer and chronic disease management contexts (8). A recent update of this scoping review conducted by the authors resulted in 36 full-spectrum KT TMFs identified (14). Eighteen were process models, eight were classic theories, three were determinant frameworks, three were evaluation frameworks, and four fit more than one approach category (14). This list of 36 full-spectrum KT TMFs provided the initial list of KT TMFs to assess for use when implementing HTR recommendations.

Consensus on the list of KT TMFs using a Modified Delphi Process

To ensure that the list of 36 full-spectrum KT TMFs was adequate and concise, a convenience sample consisting of the authors of this study reviewed this initial list to determine if any KT TMFs had been missed or could be eliminated based on HTR suitability. This sample was considered suitable as the authors had clinical training combined with expertise in KT or HTR and/or were experts at the doctorate level in these fields. A three-round modified Delphi process was undertaken (15-17). The Delphi process is iterative and used to determine expert group consensus where there is a lack of evidence and expert opinion is important (18). The first and second rounds involved independent review of each KT TMF to determine which would be suitable for HTR. Each author rated the KT TMF as “yes” , “potentially yes”, or “no” for HTR suitability. Consensus to keep the KT TMF was defined as 100% of the authors rating the KT TMF as “yes” and/or “potentially yes”. Consensus to eliminate the KT TMF was defined as

100% of the authors rating the KT TMF as "no". Any KT TMFs that did not reach consensus were discussed in subsequent rounds. The third round entailed a two-hour face-to-face meeting held in October 2018. Prior to the discussion at this meeting, the authors agreed on ground rules, principles, and criteria for selection of KT TMFs for HTR suitability (Table 1). The authors deliberated on the remaining KT TMFs until consensus was reached. Verbal consent from the participants was obtained prior and the meeting was recorded.

International Expert Survey

Selection of Experts to Review KT TMFs for HTR

HTR and KT experts were selected through purposive and snowball sampling. Names were initially derived through the KT Canada website, Health Technology Assessment international (HTAi) Disinvestment Interest group, authors of relevant publications, and in consultation with other experts. A list of HTR and KT international experts was generated by country including Canada, US, UK, Australia, and European countries (Germany, Italy, Sweden, Spain). Experts were contacted via email to participate in the study. They were sent an email, invitation letter, and information sheet. If they agreed to participate, they were sent a consent form, a survey with the list of KT TMFs identified by the modified Delphi process to rate (Supplementary file 1), and recent article on the topic as background information (3). If they were unable to participate, the next expert name on the list was contacted. This was done to ensure that there were at least two HTR and two KT experts from each of Canada, US, UK, Australia (n=16) and four HTR and four KT experts from other European countries combined (n=8) for a target sample size of 24.

Experts contacted could also suggest additional names of experts to be surveyed through snowball sampling. These names were added to the list of experts and contacted, if required, to reach a pre-defined number of participants. Representativeness was assessed by ensuring that experts came from different jurisdictions with a depth and breadth of knowledge in both KT and HTR.

Survey Development

The Enhancing The Quality and Transparency of Health Research (EQUATOR) good practice in the conduct and reporting of survey research guidelines were followed for the development of the survey (19). The survey included the list of KT TMFs, a description of each KT TMF, followed by a link to the paper that described the KT TMF, if one was available. Specific criteria used previously to select KT TMFs were used to rate each KT TMF (20). These included: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability. Each criterion was operationally defined and reviewed by FC and HMH (Supplementary file 2). There was also a section for open-ended comments. The survey was developed in Excel and pilot tested by four participants to ensure flow and functionality.

Survey Administration

The survey was administered via email to the experts starting in January 2019. Based on the criteria, each KT TMF was rated by each expert as "yes", "partially yes" or "no' and additional comments could be provided. Experts were also asked to suggest additional full-spectrum KT TMFs that could be suitable for HTR and recommend other experts that could be contacted for the study. Consensus was determined as $\geq$ 70% experts selected "yes" for the particular KT TMF. The principles and criteria described in Table 1 were also shared with the international experts for information purposes. Experts were asked to return the survey within two weeks. Two additional reminders were sent. If surveys were not returned, then another expert on the list was contacted to participate. The survey was sent out to experts until March 31, 2019 to ensure that at least two HTR and two KT experts had agreed to complete the survey from the identified countries.

Data Analysis

Modified Delphi Process

After rounds 1 and 2 of the modified Delphi process, data were analyzed descriptively by tabulating the "yes", "potentially yes", and "no" responses for HTR suitability for each KT TMF reviewed by the authors.

Survey Data

Survey data were analyzed descriptively by tabulating the "yes", "partially yes", and "no" responses for HTR suitability for each KT TMF and by HTR and KT expert sub-groups. KT TMF familiarity and missing data were also descriptively summarized.

Data from the open-ended comments section of the survey provided by the HTR and KT experts were analyzed using content analysis (21). As these data were limited in volume, content analysis was undertaken to provide a starting point in determining preliminary factors that may be important to consider for a KT TMF for HTR.

Initially, all comments from each expert were entered into Excel and categorized by KT TMF. These were read and reread to get familiarized with the data. Next, for each KT TMF, each comment was organized by response to HTR suitability as "yes", "partially yes", "no", and unfamiliar with the KT TMF. This categorization provided an understanding of what comments may or may not be important to consider for HTR suitability. Open coding and constant comparison were applied inductively to all the comments. A preliminary list of codes, sub-codes, and operational definitions were developed manually through independent review of the comments from three KT TMFs (Consolidated Framework for Implementation Research (CFIR), Stages of Research Evaluation, and Knowledge to Action (KTA) framework) by RE and HMH. A final taxonomy consisting of codes, sub-codes, and operational definitions with exemplar quotes was applied manually to the comments for the remaining KT TMFs by RE (Box 1). Manifest content analysis, defined as the development of categories as opposed to latent content analysis (defined as the development of themes), was determined to be best suited given the

nature of the open-ended comments (21). Categories were created, grouping codes under higher order headings, and formulating a general description of these categories. In addition, the frequency of comments for each code in each category was also tabulated by HTR and KT expert to determine the top categories/codes. The most prominent codes and interpretation of the data were determined through frequency counts, discussion, and consensus among FC and HMH.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Results

Modified Delphi Process

The results of the modified Delphi process are presented in Table 2. The third round resulted in the selection of 16 full-spectrum KT TMFs. There were 12 process models, two frameworks, one classic theory, and one KT TMF that fit two categories (model and framework). Twenty KT TMFs were excluded. Fourteen were too vague and not descriptive enough, two were considered 'passive' and not 'active' KT TMFs to make change happen, two were not pragmatic, and two were too specific to a given context (i.e. guideline adaptation and disability research) (Supplementary file 3).

International Expert Survey

Forty-eight KT experts and 31 HTR experts were invited to participate via email. A total of 22 experts (11 KT and 11 HTR) completed the survey. Experts were from Canada (4), US (5), UK (3), Australia (4), Germany (2), Spain (1), Italy (1), and Sweden (2). Fifty-nine percent were women, and all had graduate-level education (Masters or PhD).

Overall, of the 16 KT TMFs none received a "yes" rating for HTR suitability by ≥ 70% of the experts. The top three most highly rated KT TMFs were CFIR (22), KTA (23) and the Plan-Do-Study-Act (PDSA) cycle (24). Thirty-eight percent of the experts rated CFIR as "yes", followed by 27% each for the KTA framework and the PDSA cycle (24). The least rated KT TMFs by the experts were the KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (25), the Stages of Research Evaluation (26), the Staged Model of Innovation Development and Diffusion of Health Promotion Programs (27) which all received 0% ratings for "yes" by the experts (Figure 1). Combination of the "yes" or 'partially yes' ratings found that 86% (19/22) of the experts selected CFIR as the top rated KT TMF for HTR suitability (22).

Stratified analysis by KT and HTR Expertise

KT experts favored KTA (82%, 9/11) as another KT TMF that would be suitable for HTR (23) in addition to CFIR (91%, 10/11). HTR experts favored the Co-KT Framework (72%, 8/11) (28) and the PDSA cycle, (72%, 8/11) (24) in addition to CFIR (82%, 9/11).

Content Analysis

Forty-nine percent of the comments provided by both KT and HTR experts were related to the TMF characteristics category, followed by the TMF attributes category (19%). Implementation and user categories both had 13% each (Figure 2).

Overall, the top code was "pragmatic" under the TMF characteristics category (14%) defined as the KT TMF not being theoretical but practical and application of the TMF outside of research or academic settings. This was followed by implementation (13%), defined as the KT TMF provides operation detail on how to 'do' the implementation to achieve the HTR outputs. This included exploring determinants, their inter-relationships, and the development of interventions or strategies based on these determinants. The third top code was HTR suitability under the TMF attributes category (8%), defined as a 'strong fit' to HTR and its determinants. It also included the ability to adapt the KT TMF and tailor it to micro (individual), meso (organizational), and macro (policy) levels (3).

More KT experts than HTR experts commented on pragmatic as an important characteristic for a KT TMF (56% versus 44%). There were both positive and negative comments related to pragmatic for a KT TMF that would make it suitable for HTR. For example, one KT expert who said "yes" to HTR suitability for the PDSA cycle noted the following positive affect:

> "A basic, simple but still very useful approach" [009].

In contrast, in reference to the Stages of Research Evaluation, one HTR expert who said 'no" to HTR suitability stated the following negative affect:

> "This is also difficult to be implemented in reality as it is far from explaining the characteristics of the healthcare systems and professional interactions" [017].

More KT experts than HTR experts provided comments related to implementation (78% versus 22%). There were both positive and negative affects of comments related to implementation for a KT TMF that would make it suitable for HTR. One KT expert who said "yes" to HTR suitability for the Quality Implementation framework stated the following positive affect:

> "I'm not familiar with specifics about this framework; it certainly covers the full-spectrum of considerations for implementing new interventions; could be adapted for de-adoption/implementation "[005].

On the contrary, another KT expert who said 'no" to HTR suitability with respect to Diffusion of Innovation theory stated the following negative affect:

> "I think (as it is a general theory rather than an implementation framework/model) that it lacks sufficient guidance on how to implement/de-implement" [007].

More KT experts provided comments to HTR suitability than HTR experts (60% versus 40%). There were both positive and negative affects of comments related to HTR suitability for a KT

TMF. One HTR expert who said partially "yes" to HTR suitability for CFIR stated the following positive affect:

> "A lot of constructs have been included in CFIR, so in each case, it would probably require selection of the specific ones relevant for the HTR example" [021].

Whereas another KT expert who said 'no" to HTR suitability for the CollaboraKTion framework stated:

> "Depends on focus of work-this emphasizes need for community to decide on action whereas if you had a particular output in mind to implement/de-implement this might not be the best fit" [001].

However, HTR experts commented more on the ability to tailor the KT TMF to micro, meso, macro levels than KT experts (90% versus 10%).

Discussion

Key Findings

The focus of this study was to determine KT TMFs that could be suitable for implementation of HTR recommendations. Three key findings emerged: 1) ≥ 70% consensus (rated as "yes" by the experts) was not reached by the international KT and HTR experts on any of the current full-

spectrum KT TMFs; however when ratings of "yes" and "partially yes" were combined, CFIR was considered the most suitable KT TMF by both KT and HTR experts; 2) KT experts identified one additional KT TMF: KTA framework, whereas HTR experts identified two additional KT TMFs: co-KT framework and PDSA cycle as potentially suitable for HTR ; and 3) Overall, experts commented on three key characteristics of a KT TMF that may be important to consider: practicality, guidance on how to implement, and adaptability of the KT TMF to HTR.

Strengths

This study utilized a modified Delphi process and survey to illicit input from study authors and international KT and HTR experts. Although, experts may not have sufficient knowledge of all the KT TMFs, this was the first study that attempted to garner the opinions of experts in both fields. The field of KT and its application to HTR has been proposed as a mechanism to advance the implementation of HTR recommendations into practice (3). The selection of one determinant framework (CFIR), and three process models (KTA framework, co-KT framework, and the PDSA cycle) provides a starting point of potential KT TMFs that could be used with HTR. However, as ≥ 70% consensus was not reached by the experts, these findings need to be considered as preliminary.

Limitations

The Delphi technique has been criticized for lack of guidelines on the determination of the size of the expert panel, lack of anonymity, what is meant by 'expert' opinion, and determination on

the level of consensus (29). The sample size of five may have been too small to select KT TMFs from the list of 36 full-spectrum KT TMFs. The 100% consensus level may have been too high. There may also have been pressures of conformity at the face-to-face meeting. However, the authors had a wide-range of expertise in HTR, KT or both. The use of a facilitator and establishment of ground rules, and principles upfront were important considerations to address pressures of conformity.

Although purposeful sampling was used for the survey, the sample size of international KT and HTR experts was small which may have reduced the ability to generate consensus. However, considerable efforts were made to target experts with knowledge and practical experience in KT and/or HTR. Lastly, the selection of 70% consensus was arbitrary and determined a priori to survey administration. This level of agreement has been considered appropriate in previous Delphi studies (30), but there is no acceptable level of consensus (29).

Implications of Findings

Among the list of 16 full-spectrum KT TMFs identified through a modified Delphi process, the international experts were not able to selecta current KT TMF for HTR. Lack of familiarity with the KT TMFs could be one reason. Specifically, experts were not familiar enough with four of the 16 KT TMFs to rate them for HTR suitability. Over recent years, there has been a flurry of KT TMFs developed (8). This proliferation of KT TMFs makes it challenging for experts to keep abreast of them. Moreover, there has been criticism of the development of KT TMFs

without adequate testing, validation and research (31). Experts within the KT field may lean towards those KT TMFs that they are most familiar with (8).

Another reason experts were challenged to select a KT TMF may be the lack of understanding of the HTR process. KT experts in particular, may have found it difficult to review the KT TMFs and then apply them to HTR, as they may not be familiar enough with the HTR process itself. HTR has also been confused with terms such as 'disinvestment' and 'de-adoption', which are considered outcomes of the HTR process rather than the process itself (2). In addition, the field of HTR is under-developed and concepts have yet to be agreed upon (3). An information sheet and background paper with a description of the fields of KT and HTR was provided to the experts prior to the survey. However, these materials may not have been reviewed in advance or been a sufficient knowledge resource.

CFIR was the only KT TMF selected by both HTR and KT experts as a potential KT TMF that could be used for HTR. CFIR has been used widely and is a well-operationalized, multi-level implementation determinant framework derived from theory (32, 33). The application of CFIR and its constructs may enable users to assess facilitators and barriers to the implementation of HTR recommendations, particularly when HTR recommendations result in decreased use or removal of the technology. The assessment of facilitators and barriers has been noted as an important step within the de-adoption process of low value care (3, 34). However, future research with a focus on the application of CFIR to HTR projects is needed.

The KTA framework was primarily selected as suitable for HTR by KT experts. Its selection could be due to its wide-spread use in the KT field (35, 36). In fact, one adaptation of the KTA framework has been the Synthesis Framework for Facilitating De-adoption (34). This framework has been proposed for potential use in HTR projects (3). However, it has yet to be applied in practice. Nonetheless, the KTA framework's ability to be adaptable may be another factor in its selection primarily by KT experts.

The co-KT framework (28) and PDSA cycle (24) were primarily selected for HTR suitability by HTR experts. Both are process models (14). The co-KT framework is a linear process and may be considered simplistic to apply. The PDSA cycle has been used extensively in quality improvement as a model for change (37). It is a simple and pragmatic model to use and is adaptable within other models (38). However, it is not without its limitations (37). Subsequently, selection of these KT TMFs by HTR experts may be due their ease of use.

Implications for Future Research

Although not the key focus of this study, three key characteristics: practicality, guidance on how to implement; and adaptability of the KT TMF to HTR were identified from the open-ended comments. These key characteristics and others maybe important to further interrogate. , Future research on identifying the key elements, attributes, constructs of KT TMFs for HTR through expert interviews is needed to better understand which would influence and demonstrate an important role for HTR.

Recently, there has also been a proliferation of disinvestment frameworks or frameworks to address overuse (13, 39, 40). Some are based on KT and Implementation Science principles (13). The focus of these frameworks has been on removing or reducing low value care from practice. The application of these frameworks is still in its infancy. Although, the list of full-spectrum KT TMFs that were examined in this study did not consider these disinvestment frameworks, there may be merit in doing so.

Conclusion

This study provided insights into which KT TMFs may be suitable for HTR. Despite not attaining ≥ 70% rated as "yes" on any of the KT TMFs through the survey, experts identified four KT TMFs that could potentially be used within the context of HTR (CFIR, KTA, co-KT, and PDSA). Familiarity, adaptability and ease of use may be some of the reasons that led to their selection. Moreover, characteristics of practicality, how to implement HTR recommendations, and adaptability of the KT TMF to HTR need to be interrogated to determine if they are important in a KT TMF for HTR. The process of HTR could benefit from the field of KT and its application of KT TMFs in implementation of its recommendations. Future research on the application of KT TMFs to HTR projects will provide much needed guidance and advancement in this area.

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Award/grand number-Not Applicable

Data Availability: All data relevant to the study are included in the article or uploaded as supplementary information.

Contributors: Rosmin Esmail conducted the study, collected, analyzed, and interpreted the data. Rosmin Esmail, Fiona Clement and Heather Hanson drafted the manuscript. Rosmin Esmail, Fiona Clement, Heather Hanson, Jayna Holroyd-Leduc and Daniel J Niven contributed to the study conception and design, planning, data interpretation, and were involved in revising the manuscript for important intellectual content. Rosmin Esmail, Fiona Clement, Heather Hanson, Jayna Holroyd-Leduc and Daniel J Niven read, provided edits, and approved the final manuscript.

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Table 1: List of Criteria Developed by Authors for Round 3 of Modified Delphi Process

Criteria
The KT TMFs must have face validity (KT TMFs that are common and well-known should be included)
The KT TMFs must be active KT TMFs (passive KT TMFs were excluded)
The KT TMF must be feasible to apply to take something out of practice
The KT TMF was pragmatic (theoretical KT TMFs were excluded)
The KT TMF must be specific (vague or those that were not prescriptive were excluded)
The KT TMF could build on other KT TMFs but needed to be generic rather than for a specific context
The KT TMF is easily understood and practical
Any KT TMF that the committee was undecided on

Box 1: Taxonomy of Codes and Sub-codes for Comments Provided in the Survey

Implementation	TMF Characteristics	TMF Attributes	User	Survey Logistics/General Comments
Codes in a KT TMF related to implementation of HTR	Codes related to elements or components in a KT TMF for HTR	Codes that are considered foundational in a KT TMF for to HTR	Codes related to the use of TMFs for HTR from a user perspective	Codes related to the process of survey administration or extraneous

• Implementation
  ○ Development of intervention or strategies
  ○ Inter-related determinants
	• Pragmatic real world application
	• Straightforward
	• Engagement of relevant (patient, public, clinician) stakeholders
	  ○ Synchronicity
	• Lack specificity/insufficient details
	• Complexity
	• Prioritization of HTR
	• Resources such as economic, evidence, funding, local factors.
	  ○ Additional support
	• Adaptation
	  ○ Additional TMFs
	• Sustainability
	• Evaluation
	• Influential
	  ○ Originality (face validity)
		• HTR Suitability
		• Consideration of alternatives
		• Ability to tailor or applicability micro/meso/macro levels
		• Centrality evidence
		• Contextual fit
		• Motivation
		  ○ Challenge of removing something (feasible to apply -take something out of practice)
		• Values
		• Generalizability
		• Not a KT TMF
			• Familiarity
			• Access
			• Use by novices
				• Survey process/method oriented
				• Non-dated data

Table 2: Summary Results of KT Theories, Models and Frameworks Included and Excluded from Rounds 1 to 3 of the Modified Delphi Process

Included in Round 1	Excluded in Round 1
Consolidated Framework for Implementation Research (CFIR) (Damschroder, 2009)	A conceptual framework for planning and improving evidence-based practices (Spencer, 2013)
Stages of research evaluation (Nutbeam, 2006)	Interorganizational Relations Theory (Steckler, 2002)
Knowledge-to-Action (KTA) (Graham, 2006)	Self-Regulation Theory (Baumeister, 2011)
Quality Implementation Framework (Meyers, 2012)	Social Cognitive Theory (SCT) (Bandura, 1991)
Western Australia (WA) Health Network Policy Development and Implementation Cycle (Briggs, 2012)	Social Ecology Model for Health Promotion (Stokols, 1992)
	Transtheoretical Model of Behaviour Change (Prochaska, 1997)
Included in Round 2	**Excluded in Round 2**
Collaborative model for achieving breakthrough improvement (Institute for Healthcare Improvement, 2003)	LEAN transformation process (Lean Enterprise, 2011)
Included in Round 3	**Excluded in Round 3**
Diffusion of Innovations (Rogers, 1983)	NCHPAD (National Center on Health, Physical Activity and Disability) Knowledge, Adaptation, Translation and Scale-up (N-KTAS) Framework (Rimmer, 2016)
Healthcare Improvement Collaborative Model (Edward, 2017)	Community Connection model (Liddy, 2013)
Co-KT framework (Kitson, 2013)	Model for accelerating improvement (Associates in Process Improvement Langley, 2009)
Plan-do-study-act cycle (Deming, 1986)	Social marketing framework (National Excellence Collaborative, 2003)
A staged model of innovation development and diffusion of health promotion programs (Oldenburg, 1996)	Community-based Knowledge Translation framework (Campbell, 2010)
Evidence-driven community health improvement process (EDCHIP) (Layde, 2012)	Knowledge integration process (Glasgow, 2012)
RE-AIM (Glasgow, 1999)	Precaution Adoption Process model (Weinstein, 2008)
CollaboraKTion framework (Jenkins, 2016)	Social learning theory (Bandura, 1952)
KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (Nieva, 2005)	CAN-IMPLEMENT (Harrison, 2018)

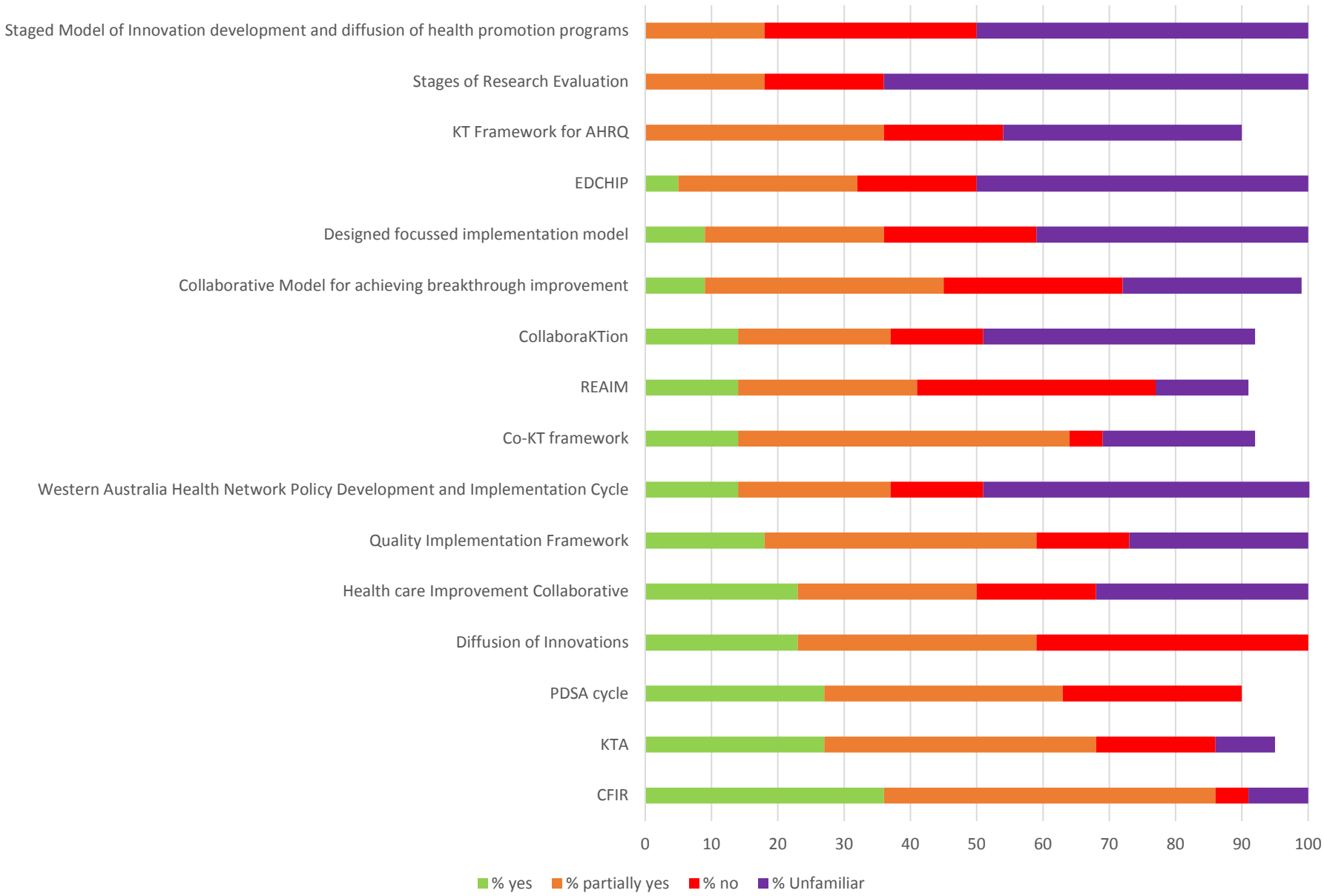
Design focused implementation model (Ramaswamy, 2018)	The translational model of the Black Dog Institute (Werner-Seidler, 2016)
	PRECEDE-PROCEED (Green, 2005)
	Community to community mentoring model (Liddy, 2013)
	Stage theory of organizational change (Butterfoss, 2008)
Total Included=16	**Total Excluded=20**

Figure legend

Figure 1: HTR Suitability of KT Theories, Models, Frameworks (TMFs) by all Experts

Figure 2: Total Comments for Each Category Provided by KT and HTR Experts

Figure 1: HTR Suitability of KT Theories, Models, Frameworks (TMFs) by all Experts



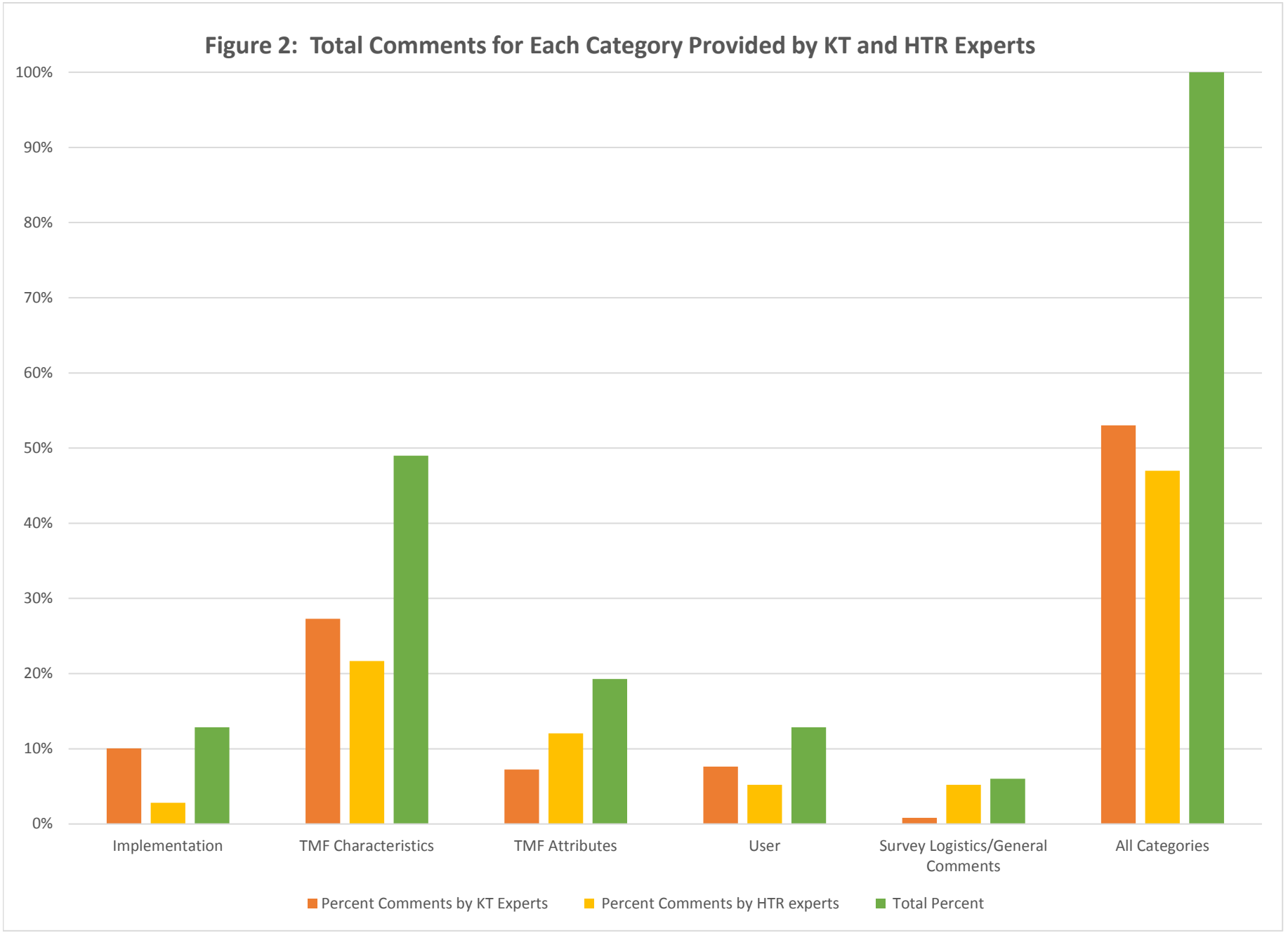


Figure 2: Total Comments for Each Category Provided by KT and HTR Experts
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Implementation
TMF Characteristics
TMF Attributes
User
Survey Logistics/General Comments
All Categories
Percent Comments by KT Experts
Percent Comments by HTR experts
Total Percent

Instructions:

Dear Expert, there are 16 full-spectrum KT theories, models and frameworks to review in column A. A brief description of each KT theory, model, framework is provided through a comment box (red triangle in corner of the cell) and a link to the paper, if available, in column B.

For each full-spectrum Knowledge Translation (KT) theory, model or framework please review each criteria in sheet #1 columns C to G and rate as yes, partially yes, or no using the drop box menu.

In sheet #1, based on your responses to columns C to G, please determine if that KT theory, model or framework is suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology) and indicate your response as yes, partially yes, or no using the drop box menu in column H.

In sheet #1, column I, please feel free to provide any comments.

Please feel free to respond to questions in rows #18 and #19.

Please save your file and return it via email to rosmin.esmail@ucalgary.ca

Definitions:

Knowledge Translation (KT): a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products, and strengthen the healthcare system (CIHR, 2017)

Health Technology Reassessment (HTR): is a structured, evidence-based assessment of the clinical, social, ethical, and economic effects of a technology currently in use to inform its optimal use in comparison to its alternatives (Noseworthy and Clement, 2012)

Full-Spectrum: A full-spectrum KT theory, model or framework is one that that has been used in the literature by study authors to inform their KT work and guide all four KT phases: i) planning/design (identifies a knowledge gap, engages stakeholders, develops an intervention), ii) implementation, iii) evaluation, and iv) sustainability/scalability (Strifler et al, 2018)

Name of Full-Spectrum Knowledge Translation (KT) Theory, Model, Framework	Link to Published KT Theory, Model, Framework (if available)	Familiarity-Are you familiar with the KT, theory, model or framework?	Logical Consistency/Plausibility-Does the KT theory, model or framework, include meaningful, face-valid explanations of proposed relationships?	Degree of specificity-Does the KT theory, model, or framework include constructs that are comprehensive of implementation determinants or specific to a set of implementation determinants that could be applied to health technology reassessment (HTR)?	Accessibility-Would non-experts be able to understand, apply and operationalize the KT theory, model, or framework to HTR?	Ease of use-Can the KT theory, model, or framework be used easily?	HTR Suitability-Based on your responses to the previous criteria, is the KT theory, model, framework suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology)?	Comments
Consolidated Framework for Implementation Research (CFIR) (Damschroder, 2009)	https://www.ncbi.nlm.nih.gov/pubmed/19664226							
Stages of Research Evaluation (Nutbeam, 2006)	Book-no link available							
Knowledge-to-Action (KTA) (Graham, 2006)	https://onlinelibrary.wiley.com/doi/abs/10.1002/chp.47							
Quality Implementation Framework (Meyers, 2012)-link to abstract only	https://www.ncbi.nlm.nih.gov/pubmed/22644083							
Western Australia (WA) Health Network Policy Development and Implementation Cycle (Briggs, 2012)	https://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-12-394							
Collaborative Model for Achieving Breakthrough improvement (Institute for Healthcare Improvement, 2003)	http://www.ihi.org/resources/Pages/IHIWhitePapers/TheBreakthroughSeriesIHIsCollaborativeModelforAchievingBreakthroughImprovement.aspx							
Diffusion of Innovations (Rogers, 3rd Edition, 1983)	https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwjjlIPX_PffAhU5HjQIHd5MDUkQFjABegQIAhAC&url=https%3A%2F%2Fteddykw2.files.wordpress.com%2F2012%2F07%2Feverett-m-rogers-diffusion-of-innovations.pdf&usg=AOvVaw3NYB0CAj1BlGacLxjbfccf							
Healthcare Improvement Collaborative Model (Edward, 2017)	https://academic.oup.com/intqhc/article/29/5/740/4082140							
Co-KT framework (Kitson, 2013)	https://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-8-54							
Plan-Do-Study-Act (PDSA) Cycles (Deming, 1986)	https://deming.org/explore/p-d-s-a							
A Staged Model of Innovation Development and Diffusion of Health Promotion Programs (Oldenburg, 1996)-link to abstract only	https://search.informit.com.au/documentSummary;dn=461377669128445;res=IELAPA							
Evidence-Driven Community Health Improvement Process (EDCHIP) (Layde, 2012)	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3489378/							
Reach Effectiveness Adoption Implementation Maintenance (RE-AIM) (Glasgow, 1999)	https://www.ncbi.nlm.nih.gov/pubmed/10474547							
CollaboraKTion framework (Jenkins, 2016)	https://www.ncbi.nlm.nih.gov/pubmed/27578195							
KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (Nieva, 2005)	https://www.ncbi.nlm.nih.gov/books/NBK20521/							
Design Focused Implementation Model (Ramaswamy, 2018)	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5778695/							
Please feel free to identify any other full-spectrum KT theories, models, or frameworks that have been missed and could be used for HTR								
Please feel free to identify names of KT or HTR experts that could be contacted for this study								

Supplementary file 2: Operational Definition of Criteria

Criteria	Operational Definition
Familiarity	Are you familiar with the KT, theory, model or framework?
Logical Consistency/Plausibility	Does the KT theory, model or framework, include meaningful, face-valid explanations of proposed relationships?
Degree of specificity	Does the KT theory, model, or framework include constructs that are comprehensive of implementation determinants or specific to a set of implementation determinants that could be applied to health technology reassessment (HTR)?
Accessibility	Would non-experts be able to understand, apply and operationalize the KT theory, model, or framework to HTR?
Ease of use	Can the KT theory, model, or framework be used easily?
HTR Suitability	Based on your responses to the previous criteria, is the KT theory, model, framework suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology)?

Supplementary file 3: List of Excluded KT Theories, Models, and Frameworks and Reason of Exclusion from the Modified Delphi Process (n=20)

KT Theories, Models and Frameworks Excluded	Too vague	Not pragmatic	Passive	Too Specific
A conceptual framework for planning and improving evidence-based practices (Spencer, 2013)	X			
Interorganizational Relations Theory (Steckler, 2002)	X			
Self-Regulation Theory (Baumeister, 2011)		X		
Social Cognitive Theory (SCT) (Bandura, 1991)			X	
Social Ecology Model for Health Promotion (Stokols, 1992)	X			
Transtheoretical Model of Behaviour Change (Prochaska, 1997)			X	
LEAN transformation process (Lean Enterprise, 2011)		X		
NCHPAD (National Center on Health, Physical Activity and Disability) Knowledge, Adaptation, Translation and Scale-up (N-KTAS) Framework (Rimmer, 2016)				X
Community Connection model (Liddy, 2013)	X			
Model for accelerating improvement (Associates in Process Improvement Langley, 2009)	X			
Social marketing framework (National Excellence Collaborative, 2003)	X			
Community based KT framework (Campbell, 2010)	X			
Knowledge integration process (Glasgow, 2012)	X			
Precaution Adoption Process model (Weinstein, 2008)	X			
Social learning theory (Bandura, 1952)	X			
CAN-IMPLEMENT (Harrison, 2018)				X (guideline focused)
The translational model of the Black Dog Institute (Werner-Seidler, 2016)	X			
PRECEDE-PROCEED (Green, 2005)	X			

KT Theories, Models and Frameworks Excluded	Too vague	Not pragmatic	Passive	Too Specific
Community to community mentoring model (Liddy, 2013)	X			
Stage theory of organization change (Butterfoss, 2008)	X			

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Identification of Knowledge Translation Theories, Models or Frameworks Suitable for Health Technology Reassessment: A Survey of International Experts

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Primary Subject Heading:	Health services research
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Keywords:	EPIDEMIOLOGY, PUBLIC HEALTH, HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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Title:

Identification of Knowledge Translation Theories, Models or Frameworks Suitable for Health Technology Reassessment: A Survey of International Experts

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Supplementary file 1: Survey Instrument

Supplementary file 2: Operational Definition of Criteria

Supplementary file 3: List of Excluded KT Theories, Models, and Frameworks and Reason of Exclusion from the Modified Delphi Process

Abstract:

Objective: Health Technology Reassessment (HTR) is a field focused on managing a technology throughout its lifecycle for optimal use. The process results in one of four possible recommendations: increase use, decrease use, no change, or complete withdrawal of the technology. However, implementation of these recommendations has been challenging. This paper explores knowledge translation (KT) theories, models and frameworks (TMFs) and their suitability for implementation of HTR recommendations.

Design: Cross-sectional survey

Participants: Purposeful sampling of international KT and HTR experts was administered between January and March 2019.

Methods: Sixteen full-spectrum KT TMFs were rated by the experts as "yes", "partially yes", or "no" on six criteria: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability. Consensus was determined as a rating of ≥ 70% responding "yes". Descriptive statistics and manifest content analysis was conducted on open-ended comments.

Results: Eleven HTR and 11 KT experts from Canada, US, UK, Australia, Germany, Spain, Italy and Sweden participated. Of the 16 KT TMFs, none received ≥ 70% rating. When ratings of "yes" and "partially yes" were combined, the Consolidated Framework for Implementation Research (CFIR) was considered the most suitable KT TMF by both KT and HTR experts (86%). One additional KT TMF was selected by KT experts: Knowledge to Action framework. HTR experts selected two additional KT TMFs: co-KT framework and Plan Do Study Act cycle. Experts identified three key characteristics of a KT TMF that may be important to consider: practicality, guidance on implementation, and KT TMF adaptability.

Conclusions: Despite not reaching an overall ≥70% rating on any of the KT TMFs, experts identified four KT TMFs suitable for HTR. Users may apply these KT TMFs in the implementation of HTR recommendations. In addition, KT TMFs characteristics relevant to the field of HTR need to be explored further.

Key words: Health Technology Reassessment, Disinvestment, De-adoption, De-implementation, Theories, Models and Frameworks, Knowledge Translation, Implementation Science.

Article Summary

Strengths and Limitations of Study

- This was the first study to solicit the perspectives of international HTR and KT international experts on the suitability of KT TMFs for HTR.
- Purposeful and snowball sampling was employed to obtain HTR and KT experts from different jurisdictions with a depth and breadth of knowledge in both KT and HTR to ensure a representative sample.
- Through a survey, experts were asked to rate each KT TMF as "yes", "partially yes", or "no" on six criteria: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability to select potential KT TMFs for HTR.
- Only full-spectrum KT TMFs (KT phases: planning/design, implementation, evaluation, and sustainability/scalability) were included as these phases are critical to the KT process and necessary for the HTR process.
- The sample size of HTR and KT experts was small which may have reduced the ability to generate consensus (≥ 70% experts selected "yes") for a suitable KT TMF for HTR.

Background

Health Technology Reassessment (HTR) is the systematic process of evaluating technologies that are currently in the health system to ensure that they are being used optimally (1). Recommendations from the HTR process can result in the increase use, decrease use, no change, or complete withdrawal of the technology (2). However, implementation of these recommendations has been challenging (2). It has been argued that the field of knowledge translation (KT) could play a role in the implementation process for HTR recommendations (3). KT has been described as "a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of [populations], provide more effective health services and products, and strengthen the healthcare system" (4). In essence, KT is the application of putting knowledge into practice and policy. KT approaches could be used in the HTR process to bridge the gap between the generation of recommendations regarding optimal technology use and their implementation in practice (3) Thus, KT can be seen as complimentary to the HTR process, but there has been a paucity of research in this area (3). Moreover, there is a gap in our understanding of which KT theories, models, or frameworks (KT TMFs hereafter) would be best suited for the translation of HTR recommendations (3).

In the literature, two narrative reviews and two scoping reviews have reported from 41 to 159 KT TMFs depending on how they are identified and considered (5-8). KT TMFs have been used in different contexts, settings, and populations (5-8). Moreover, there has been some use of

the KT interventions, strategies, and TMFs to decrease or remove low value care (9, 10). These KT TMFs have been used to help identify determinants, barriers and enablers to behaviour change related to HTR (11, 12). However, the use of these KT TMFs has not been applied consistently to the development of KT interventions or the field of HTR (3, 13). There are also no recommendations about which KT TMFs could be used for HTR. Through an international survey of KT and HTR experts, this study aims to provide an understanding of which KT TMFs could be appropriate for the HTR process and implementation of its recommendations.

Methods

This study used three approaches to the selection of KT TMFs for HTR: identification of suitable KT TMFs, consensus on the list of KT TMFs through a modified Delphi process, and selection of potentially suitable KT TMFs through a survey of international KT and HTR experts. Ethics approval was obtained from the University of Calgary's Conjoint Health Research Ethics Board [REB#17-0932].

Identification of Suitable KT TMFs

Only full-spectrum KT TMFs were included. "Full-spectrum" includes all four KT phases: planning/design, implementation, evaluation, and sustainability/scalability (8). These four KT

phases are critical to the KT process and are thought to be necessary for the HTR process and implementation of its recommendations (3). A recent scoping review provided a preliminary list of 26 full-spectrum KT TMFs within cancer and chronic disease management contexts (8). A recent update of this scoping review conducted by the authors resulted in 36 full-spectrum KT TMFs identified (14). Eighteen were process models, eight were classic theories, three were determinant frameworks, three were evaluation frameworks, and four fit more than one approach category (14). This list of 36 full-spectrum KT TMFs provided the initial list of KT TMFs to assess for use when implementing HTR recommendations.

Consensus on the list of KT TMFs using a Modified Delphi Process

To ensure that the list of 36 full-spectrum KT TMFs was adequate and concise, a convenience sample consisting of the authors of this study reviewed this initial list to determine if any KT TMFs had been missed or could be eliminated based on HTR suitability. This sample was considered suitable as the authors had clinical training combined with expertise in KT or HTR and/or were experts at the doctorate level in these fields. A three-round modified Delphi process was undertaken (15-17). The Delphi process is iterative and used to determine expert group consensus where there is a lack of evidence and expert opinion is important (18). The first and second rounds involved independent review of each KT TMF to determine which would be suitable for HTR. Each author rated the KT TMF as “yes” , “potentially yes”, or “no” for HTR suitability. Consensus to keep the KT TMF was defined as 100% of the authors rating the KT TMF as “yes” and/or “potentially yes”. Consensus to eliminate the KT TMF was defined as

100% of the authors rating the KT TMF as "no". Any KT TMFs that did not reach consensus were discussed in subsequent rounds. The third round entailed a two-hour face-to-face meeting held in October 2018. Prior to the discussion at this meeting, the authors agreed on ground rules, principles, and criteria for selection of KT TMFs for HTR suitability (Table 1). The authors deliberated on the remaining KT TMFs until consensus was reached. Verbal consent from the participants was obtained prior and the meeting was recorded.

International Expert Survey

Selection of Experts to Review KT TMFs for HTR

HTR and KT experts were selected through purposive and snowball sampling. Names were initially derived through the KT Canada website, Health Technology Assessment international (HTAi) Disinvestment Interest group, authors of relevant publications, and in consultation with other experts. A list of HTR and KT international experts was generated by country including Canada, US, UK, Australia, and European countries (Germany, Italy, Sweden, Spain). Experts were contacted via email to participate in the study. They were sent an email, invitation letter, and information sheet. If they agreed to participate, they were sent a consent form, a survey with the list of KT TMFs identified by the modified Delphi process to rate (Supplementary file 1), and recent article on the topic as background information (3). If they were unable to participate, the next expert name on the list was contacted. This was done to ensure that there were at least two HTR and two KT experts from each of Canada, US, UK, Australia (n=16) and four HTR and four KT experts from other European countries combined (n=8) for a target sample size of 24.

Experts contacted could also suggest additional names of experts to be surveyed through snowball sampling. These names were added to the list of experts and contacted, if required, to reach a pre-defined number of participants. Representativeness was assessed by ensuring that experts came from different jurisdictions with a depth and breadth of knowledge in both KT and HTR.

Survey Development

The Enhancing The Quality and Transparency of Health Research (EQUATOR) good practice in the conduct and reporting of survey research guidelines were followed for the development of the survey (19). The survey included the list of KT TMFs, a description of each KT TMF, followed by a link to the paper that described the KT TMF, if one was available. Specific criteria used previously to select KT TMFs were used to rate each KT TMF (20). These included: familiarity, logical consistency/plausibility, degree of specificity, accessibility, ease of use, and HTR suitability. Each criterion was operationally defined and reviewed by FC and HMH (Supplementary file 2). There was also a section for open-ended comments. The survey was developed in Excel and pilot tested by four participants to ensure flow and functionality.

Survey Administration

The survey was administered via email to the experts starting in January 2019. Based on the criteria, each KT TMF was rated by each expert as "yes", "partially yes" or "no' and additional comments could be provided. Experts were also asked to suggest additional full-spectrum KT TMFs that could be suitable for HTR and recommend other experts that could be contacted for the study. Consensus was determined as $\geq$ 70% experts selected "yes" for the particular KT TMF. The principles and criteria described in Table 1 were also shared with the international experts for information purposes. Experts were asked to return the survey within two weeks. Two additional reminders were sent. If surveys were not returned, then another expert on the list was contacted to participate. The survey was sent out to experts until March 31, 2019 to ensure that at least two HTR and two KT experts had agreed to complete the survey from the identified countries.

Data Analysis

Modified Delphi Process

After rounds 1 and 2 of the modified Delphi process, data were analyzed descriptively by tabulating the "yes", "potentially yes", and "no" responses for HTR suitability for each KT TMF reviewed by the authors.

Survey Data

Survey data were analyzed descriptively by tabulating the "yes", "partially yes", and "no" responses for HTR suitability for each KT TMF and by HTR and KT expert sub-groups. KT TMF familiarity and missing data were also descriptively summarized.

Data from the open-ended comments section of the survey provided by the HTR and KT experts were analyzed using content analysis (21). As these data were limited in volume, content analysis was undertaken to provide a starting point in determining preliminary factors that may be important to consider for a KT TMF for HTR.

Initially, all comments from each expert were entered into Excel and categorized by KT TMF. These were read and reread to get familiarized with the data. Next, for each KT TMF, each comment was organized by response to HTR suitability as "yes", "partially yes", "no", and unfamiliar with the KT TMF. This categorization provided an understanding of what comments may or may not be important to consider for HTR suitability. Open coding and constant comparison were applied inductively to all the comments. A preliminary list of codes, sub-codes, and operational definitions were developed manually through independent review of the comments from three KT TMFs (Consolidated Framework for Implementation Research (CFIR), Stages of Research Evaluation, and Knowledge to Action (KTA) framework) by RE and HMH. A final taxonomy consisting of codes, sub-codes, and operational definitions with exemplar quotes was applied manually to the comments for the remaining KT TMFs by RE (Box 1). Manifest content analysis, defined as the development of categories as opposed to latent content analysis (defined as the development of themes), was determined to be best suited given the

nature of the open-ended comments (21). Categories were created, grouping codes under higher order headings, and formulating a general description of these categories. In addition, the frequency of comments for each code in each category was also tabulated by HTR and KT expert to determine the top categories/codes. The most prominent codes and interpretation of the data were determined through frequency counts, discussion, and consensus among FC and HMH.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Results

Modified Delphi Process

The results of the modified Delphi process are presented in Table 2. The third round resulted in the selection of 16 full-spectrum KT TMFs. There were 12 process models, two frameworks, one classic theory, and one KT TMF that fit two categories (model and framework). Twenty KT TMFs were excluded. Fourteen were too vague and not descriptive enough, two were considered 'passive' and not 'active' KT TMFs to make change happen, two were not pragmatic, and two were too specific to a given context (i.e. guideline adaptation and disability research) (Supplementary file 3).

International Expert Survey

Forty-eight KT experts and 31 HTR experts were invited to participate via email. A total of 22 experts (11 KT and 11 HTR) completed the survey. Experts were from Canada (4), US (5), UK (3), Australia (4), Germany (2), Spain (1), Italy (1), and Sweden (2). Fifty-nine percent were women, and all had graduate-level education (Masters or PhD).

Overall, of the 16 KT TMFs none received a "yes" rating for HTR suitability by ≥ 70% of the experts. The top three most highly rated KT TMFs were CFIR (22), KTA (23) and the Plan-Do-Study-Act (PDSA) cycle (24). Thirty-eight percent of the experts rated CFIR as "yes", followed by 27% each for the KTA framework and the PDSA cycle (24). The least rated KT TMFs by the experts were the KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (25), the Stages of Research Evaluation (26), the Staged Model of Innovation Development and Diffusion of Health Promotion Programs (27) which all received 0% ratings for "yes" by the experts (Figure 1). Combination of the "yes" or 'partially yes' ratings found that 86% (19/22) of the experts selected CFIR as the top rated KT TMF for HTR suitability (22).

Stratified analysis by KT and HTR Expertise

KT experts favored KTA (82%, 9/11) as another KT TMF that would be suitable for HTR (23) in addition to CFIR (91%, 10/11). HTR experts favored the Co-KT Framework (72%, 8/11) (28) and the PDSA cycle, (72%, 8/11) (24) in addition to CFIR (82%, 9/11).

Content Analysis

Forty-nine percent of the comments provided by both KT and HTR experts were related to the TMF characteristics category, followed by the TMF attributes category (19%). Implementation and user categories both had 13% each (Figure 2).

Overall, the top code was "pragmatic" under the TMF characteristics category (14%) defined as the KT TMF not being theoretical but practical and application of the TMF outside of research or academic settings. This was followed by implementation (13%), defined as the KT TMF provides operation detail on how to 'do' the implementation to achieve the HTR outputs. This included exploring determinants, their inter-relationships, and the development of interventions or strategies based on these determinants. The third top code was HTR suitability under the TMF attributes category (8%), defined as a 'strong fit' to HTR and its determinants. It also included the ability to adapt the KT TMF and tailor it to micro (individual), meso (organizational), and macro (policy) levels (3).

More KT experts than HTR experts commented on pragmatic as an important characteristic for a KT TMF (56% versus 44%). There were both positive and negative comments related to pragmatic for a KT TMF that would make it suitable for HTR. For example, one KT expert who said "yes" to HTR suitability for the PDSA cycle noted the following positive affect:

> "A basic, simple but still very useful approach" [009].

In contrast, in reference to the Stages of Research Evaluation, one HTR expert who said 'no" to HTR suitability stated the following negative affect:

> "This is also difficult to be implemented in reality as it is far from explaining the characteristics of the healthcare systems and professional interactions" [017].

More KT experts than HTR experts provided comments related to implementation (78% versus 22%). There were both positive and negative affects of comments related to implementation for a KT TMF that would make it suitable for HTR. One KT expert who said "yes" to HTR suitability for the Quality Implementation framework stated the following positive affect:

> "I'm not familiar with specifics about this framework; it certainly covers the full-spectrum of considerations for implementing new interventions; could be adapted for de-adoption/implementation "[005].

On the contrary, another KT expert who said 'no" to HTR suitability with respect to Diffusion of Innovation theory stated the following negative affect:

> "I think (as it is a general theory rather than an implementation framework/model) that it lacks sufficient guidance on how to implement/de-implement" [007].

More KT experts provided comments to HTR suitability than HTR experts (60% versus 40%). There were both positive and negative affects of comments related to HTR suitability for a KT

TMF. One HTR expert who said partially "yes" to HTR suitability for CFIR stated the following positive affect:

> "A lot of constructs have been included in CFIR, so in each case, it would probably require selection of the specific ones relevant for the HTR example" [021].

Whereas another KT expert who said 'no" to HTR suitability for the CollaboraKTion framework stated:

> "Depends on focus of work-this emphasizes need for community to decide on action whereas if you had a particular output in mind to implement/de-implement this might not be the best fit" [001].

However, HTR experts commented more on the ability to tailor the KT TMF to micro, meso, macro levels than KT experts (90% versus 10%).

Discussion

Key Findings

The focus of this study was to determine KT TMFs that could be suitable for implementation of HTR recommendations. Three key findings emerged: 1) ≥ 70% consensus (rated as "yes" by the experts) was not reached by the international KT and HTR experts on any of the current full-

spectrum KT TMFs; however when ratings of "yes" and "partially yes" were combined, CFIR was considered the most suitable KT TMF by both KT and HTR experts; 2) KT experts identified one additional KT TMF: KTA framework, whereas HTR experts identified two additional KT TMFs: co-KT framework and PDSA cycle as potentially suitable for HTR ; and 3) Overall, experts commented on three key characteristics of a KT TMF that may be important to consider: practicality, guidance on how to implement, and adaptability of the KT TMF to HTR.

Strengths

This study utilized a modified Delphi process and survey to illicit input from study authors and international KT and HTR experts. Although, experts may not have sufficient knowledge of all the KT TMFs, this was the first study that attempted to garner the opinions of experts in both fields. The field of KT and its application to HTR has been proposed as a mechanism to advance the implementation of HTR recommendations into practice (3). The selection of one determinant framework (CFIR), and three process models (KTA framework, co-KT framework, and the PDSA cycle) provides a starting point of potential KT TMFs that could be used with HTR. However, as ≥ 70% consensus was not reached by the experts, these findings need to be considered as preliminary.

Limitations

The Delphi technique has been criticized for lack of guidelines on the determination of the size of the expert panel, lack of anonymity, what is meant by 'expert' opinion, and determination on

the level of consensus (29). The sample size of five may have been too small to select KT TMFs from the list of 36 full-spectrum KT TMFs. The 100% consensus level may have been too high. There may also have been pressures of conformity at the face-to-face meeting. However, the authors had a wide-range of expertise in HTR, KT or both. The use of a facilitator and establishment of ground rules, and principles upfront were important considerations to address pressures of conformity.

Although purposeful sampling was used for the survey, the sample size of international KT and HTR experts was small which may have reduced the ability to generate consensus. However, considerable efforts were made to target experts with knowledge and practical experience in KT and/or HTR. Lastly, the selection of 70% consensus was arbitrary and determined a priori to survey administration. This level of agreement has been considered appropriate in previous Delphi studies (30), but there is no acceptable level of consensus (29).

Implications of Findings

Among the list of 16 full-spectrum KT TMFs identified through a modified Delphi process, the international experts were not able to selecta current KT TMF for HTR. Lack of familiarity with the KT TMFs could be one reason. Specifically, experts were not familiar enough with four of the 16 KT TMFs to rate them for HTR suitability. Over recent years, there has been a flurry of KT TMFs developed (8). This proliferation of KT TMFs makes it challenging for experts to keep abreast of them. Moreover, there has been criticism of the development of KT TMFs

without adequate testing, validation and research (31). Experts within the KT field may lean towards those KT TMFs that they are most familiar with (8).

Another reason experts were challenged to select a KT TMF may be the lack of understanding of the HTR process. KT experts in particular, may have found it difficult to review the KT TMFs and then apply them to HTR, as they may not be familiar enough with the HTR process itself. HTR has also been confused with terms such as 'disinvestment' and 'de-adoption', which are considered outcomes of the HTR process rather than the process itself (2). In addition, the field of HTR is under-developed and concepts have yet to be agreed upon (3). An information sheet and background paper with a description of the fields of KT and HTR was provided to the experts prior to the survey. However, these materials may not have been reviewed in advance or been a sufficient knowledge resource.

CFIR was the only KT TMF selected by both HTR and KT experts as a potential KT TMF that could be used for HTR. CFIR has been used widely and is a well-operationalized, multi-level implementation determinant framework derived from theory (32, 33). The application of CFIR and its constructs may enable users to assess facilitators and barriers to the implementation of HTR recommendations, particularly when HTR recommendations result in decreased use or removal of the technology. The assessment of facilitators and barriers has been noted as an important step within the de-adoption process of low value care (3, 34). However, future research with a focus on the application of CFIR to HTR projects is needed.

The KTA framework was primarily selected as suitable for HTR by KT experts. Its selection could be due to its wide-spread use in the KT field (35, 36). In fact, one adaptation of the KTA framework has been the Synthesis Framework for Facilitating De-adoption (34). This framework has been proposed for potential use in HTR projects (3). However, it has yet to be applied in practice. Nonetheless, the KTA framework's ability to be adaptable may be another factor in its selection primarily by KT experts.

The co-KT framework (28) and PDSA cycle (24) were primarily selected for HTR suitability by HTR experts. Both are process models (14). The co-KT framework is a linear process and may be considered simplistic to apply. The PDSA cycle has been used extensively in quality improvement as a model for change (37). It is a simple and pragmatic model to use and is adaptable within other models (38). However, it is not without its limitations (37). Subsequently, selection of these KT TMFs by HTR experts may be due their ease of use.

Implications for Future Research

Although not the key focus of this study, three key characteristics: practicality, guidance on how to implement; and adaptability of the KT TMF to HTR were identified from the open-ended comments. These key characteristics and others maybe important to further interrogate. , Future research on identifying the key elements, attributes, constructs of KT TMFs for HTR through expert interviews is needed to better understand which would influence and demonstrate an important role for HTR.

Recently, there has also been a proliferation of disinvestment frameworks or frameworks to address overuse (13, 39, 40). Some are based on KT and Implementation Science principles (13). The focus of these frameworks has been on removing or reducing low value care from practice. The application of these frameworks is still in its infancy. Although, the list of full-spectrum KT TMFs that were examined in this study did not consider these disinvestment frameworks, there may be merit in doing so.

Conclusion

This study provided insights into which KT TMFs may be suitable for HTR. Despite not attaining ≥ 70% rated as "yes" on any of the KT TMFs through the survey, experts identified four KT TMFs that could potentially be used within the context of HTR (CFIR, KTA, co-KT, and PDSA). Familiarity, adaptability and ease of use may be some of the reasons that led to their selection. Moreover, characteristics of practicality, how to implement HTR recommendations, and adaptability of the KT TMF to HTR need to be interrogated to determine if they are important in a KT TMF for HTR. The process of HTR could benefit from the field of KT and its application of KT TMFs in implementation of its recommendations. Future research on the application of KT TMFs to HTR projects will provide much needed guidance and advancement in this area.

Competing Interests: None.

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Award/grand number-Not Applicable

Data Availability: All data relevant to the study are included in the article or uploaded as supplementary information.

Contributors: Rosmin Esmail conducted the study, collected, analyzed, and interpreted the data. Rosmin Esmail, Fiona Clement and Heather Hanson drafted the manuscript. Rosmin Esmail, Fiona Clement, Heather Hanson, Jayna Holroyd-Leduc and Daniel J Niven contributed to the study conception and design, planning, data interpretation, and were involved in revising the manuscript for important intellectual content. Rosmin Esmail, Fiona Clement, Heather Hanson, Jayna Holroyd-Leduc and Daniel J Niven read, provided edits, and approved the final manuscript.

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Table 1: List of Criteria Developed by Authors for Round 3 of Modified Delphi Process

Criteria
The KT TMFs must have face validity (KT TMFs that are common and well-known should be included)
The KT TMFs must be active KT TMFs (passive KT TMFs were excluded)
The KT TMF must be feasible to apply to take something out of practice
The KT TMF was pragmatic (theoretical KT TMFs were excluded)
The KT TMF must be specific (vague or those that were not prescriptive were excluded)
The KT TMF could build on other KT TMFs but needed to be generic rather than for a specific context
The KT TMF is easily understood and practical
Any KT TMF that the committee was undecided on

Box 1: Taxonomy of Codes and Sub-codes for Comments Provided in the Survey

Implementation	TMF Characteristics	TMF Attributes	User	Survey Logistics/General Comments
Codes in a KT TMF related to implementation of HTR	Codes related to elements or components in a KT TMF for HTR	Codes that are considered foundational in a KT TMF for to HTR	Codes related to the use of TMFs for HTR from a user perspective	Codes related to the process of survey administration or extraneous

• Implementation
  ○ Development of intervention or strategies
  ○ Inter-related determinants
	• Pragmatic real world application
	• Straightforward
	• Engagement of relevant (patient, public, clinician) stakeholders
	  ○ Synchronicity
	• Lack specificity/insufficient details
	• Complexity
	• Prioritization of HTR
	• Resources such as economic, evidence, funding, local factors.
	  ○ Additional support
	• Adaptation
	  ○ Additional TMFs
	• Sustainability
	• Evaluation
	• Influential
	  ○ Originality (face validity)
		• HTR Suitability
		• Consideration of alternatives
		• Ability to tailor or applicability micro/meso/macro levels
		• Centrality evidence
		• Contextual fit
		• Motivation
		  ○ Challenge of removing something (feasible to apply -take something out of practice)
		• Values
		• Generalizability
		• Not a KT TMF
			• Familiarity
			• Access
			• Use by novices
				• Survey process/method oriented
				• Non-dated data

Table 2: Summary Results of KT Theories, Models and Frameworks Included and Excluded from Rounds 1 to 3 of the Modified Delphi Process

Included in Round 1	Excluded in Round 1
Consolidated Framework for Implementation Research (CFIR) (Damschroder, 2009)	A conceptual framework for planning and improving evidence-based practices (Spencer, 2013)
Stages of research evaluation (Nutbeam, 2006)	Interorganizational Relations Theory (Steckler, 2002)
Knowledge-to-Action (KTA) (Graham, 2006)	Self-Regulation Theory (Baumeister, 2011)
Quality Implementation Framework (Meyers, 2012)	Social Cognitive Theory (SCT) (Bandura, 1991)
Western Australia (WA) Health Network Policy Development and Implementation Cycle (Briggs, 2012)	Social Ecology Model for Health Promotion (Stokols, 1992)
	Transtheoretical Model of Behaviour Change (Prochaska, 1997)
Included in Round 2	**Excluded in Round 2**
Collaborative model for achieving breakthrough improvement (Institute for Healthcare Improvement, 2003)	LEAN transformation process (Lean Enterprise, 2011)
Included in Round 3	**Excluded in Round 3**
Diffusion of Innovations (Rogers, 1983)	NCHPAD (National Center on Health, Physical Activity and Disability) Knowledge, Adaptation, Translation and Scale-up (N-KTAS) Framework (Rimmer, 2016)
Healthcare Improvement Collaborative Model (Edward, 2017)	Community Connection model (Liddy, 2013)
Co-KT framework (Kitson, 2013)	Model for accelerating improvement (Associates in Process Improvement Langley, 2009)
Plan-do-study-act cycle (Deming, 1986)	Social marketing framework (National Excellence Collaborative, 2003)
A staged model of innovation development and diffusion of health promotion programs (Oldenburg, 1996)	Community-based Knowledge Translation framework (Campbell, 2010)
Evidence-driven community health improvement process (EDCHIP) (Layde, 2012)	Knowledge integration process (Glasgow, 2012)
RE-AIM (Glasgow, 1999)	Precaution Adoption Process model (Weinstein, 2008)
CollaboraKTion framework (Jenkins, 2016)	Social learning theory (Bandura, 1952)
KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (Nieva, 2005)	CAN-IMPLEMENT (Harrison, 2018)

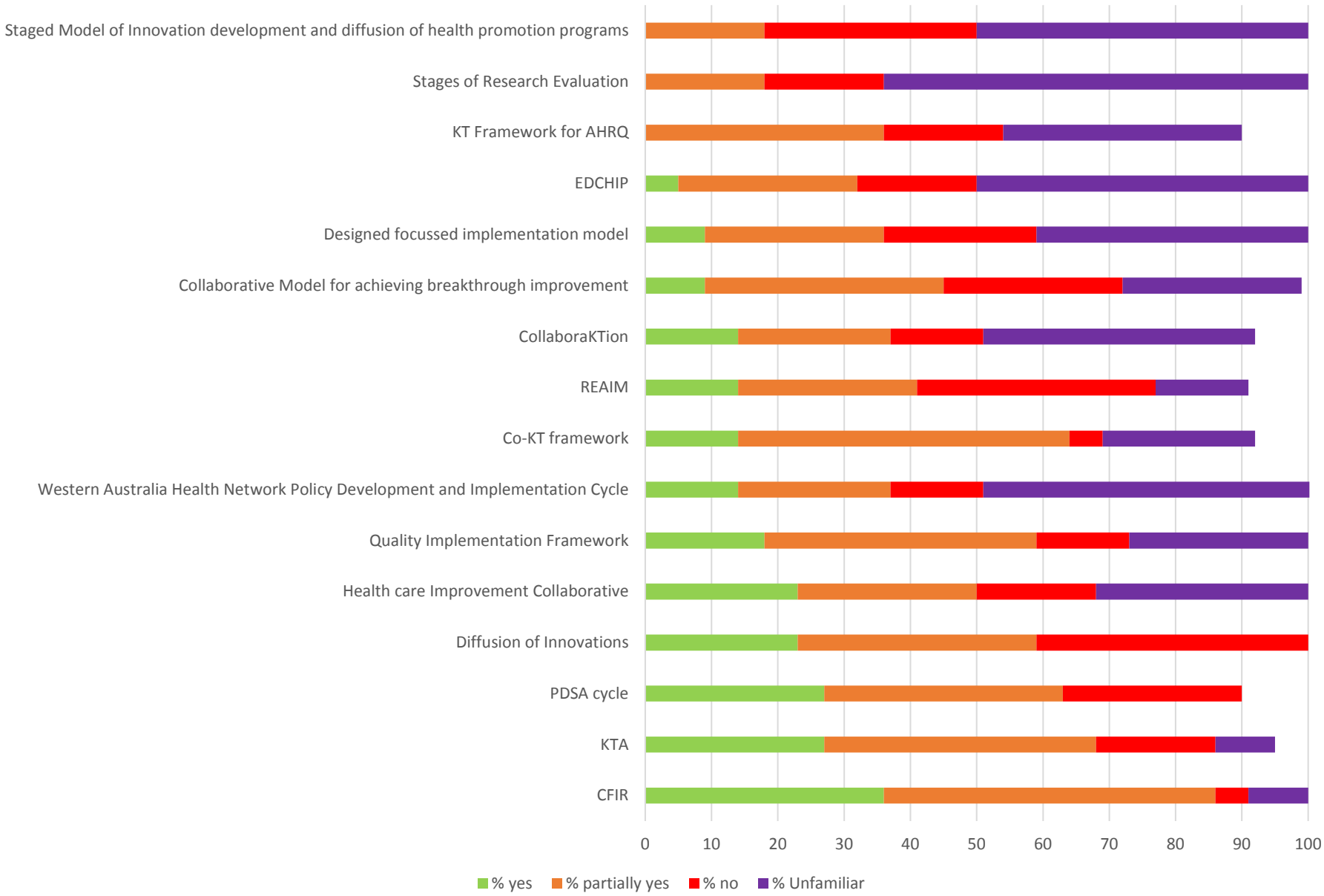
Design focused implementation model (Ramaswamy, 2018)	The translational model of the Black Dog Institute (Werner-Seidler, 2016)
	PRECEDE-PROCEED (Green, 2005)
	Community to community mentoring model (Liddy, 2013)
	Stage theory of organizational change (Butterfoss, 2008)
Total Included=16	**Total Excluded=20**

Figure legend

Figure 1: HTR Suitability of KT Theories, Models, Frameworks (TMFs) by all Experts

Figure 2: Total Comments for Each Category Provided by KT and HTR Experts

Figure 1: HTR Suitability of KT Theories, Models, Frameworks (TMFs) by all Experts



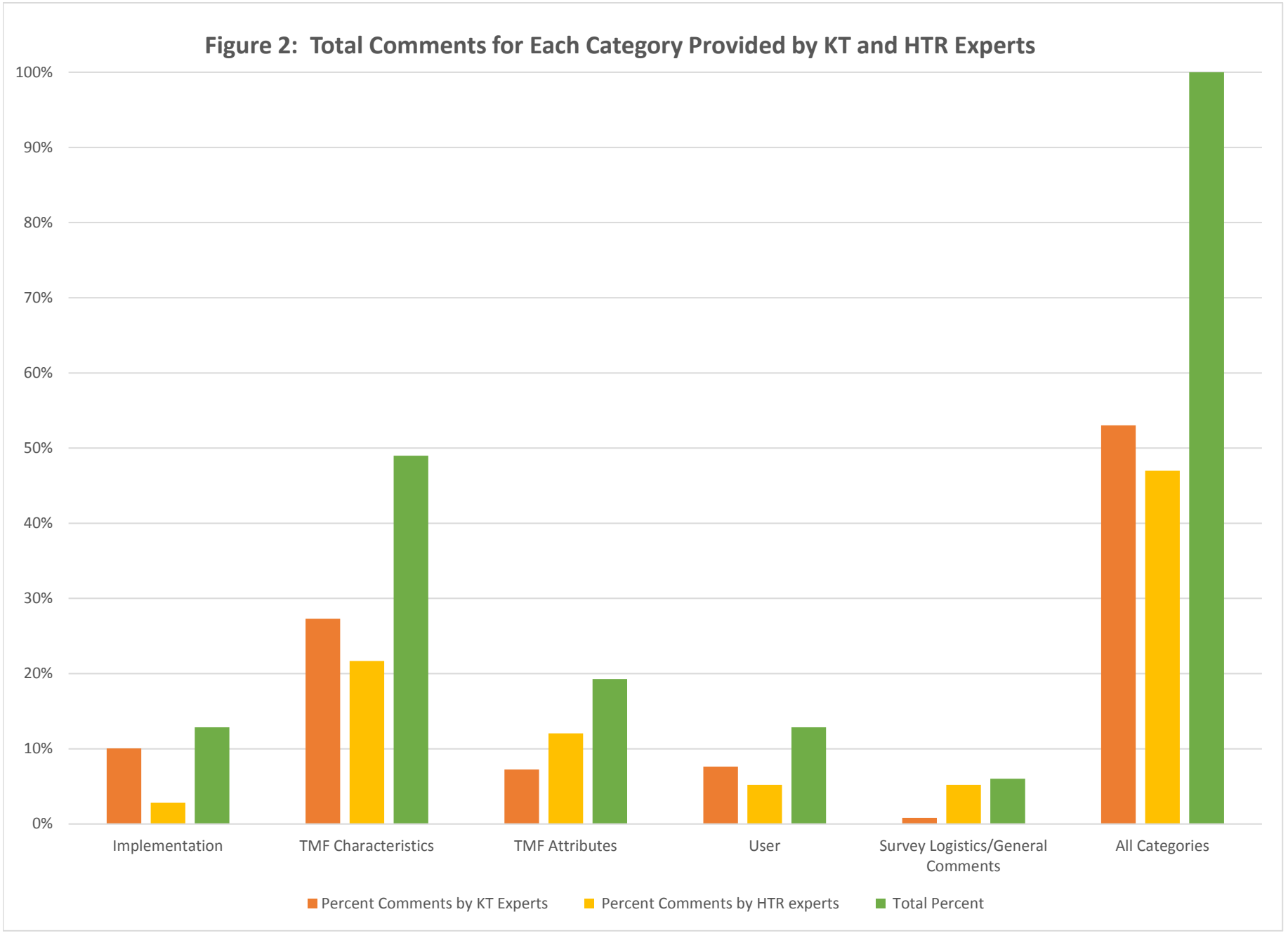


Figure 2: Total Comments for Each Category Provided by KT and HTR Experts
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Implementation
TMF Characteristics
TMF Attributes
User
Survey Logistics/General Comments
All Categories
Percent Comments by KT Experts
Percent Comments by HTR experts
Total Percent

Instructions:

Dear Expert, there are 16 full-spectrum KT theories, models and frameworks to review in column A. A brief description of each KT theory, model, framework is provided through a comment box (red triangle in corner of the cell) and a link to the paper, if available, in column B.

For each full-spectrum Knowledge Translation (KT) theory, model or framework please review each criteria in sheet #1 columns C to G and rate as yes, partially yes, or no using the drop box menu.

In sheet #1, based on your responses to columns C to G, please determine if that KT theory, model or framework is suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology) and indicate your response as yes, partially yes, or no using the drop box menu in column H.

In sheet #1, column I, please feel free to provide any comments.

Please feel free to respond to questions in rows #18 and #19.

Please save your file and return it via email to rosmin.esmail@ucalgary.ca

Definitions:

Knowledge Translation (KT): a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products, and strengthen the healthcare system (CIHR, 2017)

Health Technology Reassessment (HTR): is a structured, evidence-based assessment of the clinical, social, ethical, and economic effects of a technology currently in use to inform its optimal use in comparison to its alternatives (Noseworthy and Clement, 2012)

Full-Spectrum: A full-spectrum KT theory, model or framework is one that that has been used in the literature by study authors to inform their KT work and guide all four KT phases: i) planning/design (identifies a knowledge gap, engages stakeholders, develops an intervention), ii) implementation, iii) evaluation, and iv) sustainability/scalability (Strifler et al, 2018)

Name of Full-Spectrum Knowledge Translation (KT) Theory, Model, Framework	Link to Published KT Theory, Model, Framework (if available)	Familiarity-Are you familiar with the KT, theory, model or framework?	Logical Consistency/Plausibility-Does the KT theory, model or framework, include meaningful, face-valid explanations of proposed relationships?	Degree of specificity-Does the KT theory, model, or framework include constructs that are comprehensive of implementation determinants or specific to a set of implementation determinants that could be applied to health technology reassessment (HTR)?	Accessibility-Would non-experts be able to understand, apply and operationalize the KT theory, model, or framework to HTR?	Ease of use-Can the KT theory, model, or framework be used easily?	HTR Suitability-Based on your responses to the previous criteria, is the KT theory, model, framework suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology)?	Comments
Consolidated Framework for Implementation Research (CFIR) (Damschroder, 2009)	https://www.ncbi.nlm.nih.gov/pubmed/19664226							
Stages of Research Evaluation (Nutbeam, 2006)	Book-no link available							
Knowledge-to-Action (KTA) (Graham, 2006)	https://onlinelibrary.wiley.com/doi/abs/10.1002/chp.47							
Quality Implementation Framework (Meyers, 2012)-link to abstract only	https://www.ncbi.nlm.nih.gov/pubmed/22644083							
Western Australia (WA) Health Network Policy Development and Implementation Cycle (Briggs, 2012)	https://bmchealthservres.biomedcentral.com/articles/10.1186/1472-6963-12-394							
Collaborative Model for Achieving Breakthrough improvement (Institute for Healthcare Improvement, 2003)	http://www.ihi.org/resources/Pages/IHIWhitePapers/TheBreakthroughSeriesIHIsCollaborativeModelforAchievingBreakthroughImprovement.aspx							
Diffusion of Innovations (Rogers, 3rd Edition, 1983)	https://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=2ahUKEwjjlIPX_PffAhU5HjQIHd5MDUkQFjABegQIAhAC&url=https%3A%2F%2Fteddykw2.files.wordpress.com%2F2012%2F07%2Feverett-m-rogers-diffusion-of-innovations.pdf&usg=AOvVaw3NYB0CAj1BlGacLxjbfccf							
Healthcare Improvement Collaborative Model (Edward, 2017)	https://academic.oup.com/intqhc/article/29/5/740/4082140							
Co-KT framework (Kitson, 2013)	https://implementationscience.biomedcentral.com/articles/10.1186/1748-5908-8-54							
Plan-Do-Study-Act (PDSA) Cycles (Deming, 1986)	https://deming.org/explore/p-d-s-a							
A Staged Model of Innovation Development and Diffusion of Health Promotion Programs (Oldenburg, 1996)-link to abstract only	https://search.informit.com.au/documentSummary;dn=461377669128445;res=IELAPA							
Evidence-Driven Community Health Improvement Process (EDCHIP) (Layde, 2012)	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3489378/							
Reach Effectiveness Adoption Implementation Maintenance (RE-AIM) (Glasgow, 1999)	https://www.ncbi.nlm.nih.gov/pubmed/10474547							
CollaboraKTion framework (Jenkins, 2016)	https://www.ncbi.nlm.nih.gov/pubmed/27578195							
KT framework for Agency for Healthcare Research and Quality (AHRQ) patient safety portfolio and grantees (Nieva, 2005)	https://www.ncbi.nlm.nih.gov/books/NBK20521/							
Design Focused Implementation Model (Ramaswamy, 2018)	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5778695/							
Please feel free to identify any other full-spectrum KT theories, models, or frameworks that have been missed and could be used for HTR								
Please feel free to identify names of KT or HTR experts that could be contacted for this study								

Supplementary file 2: Operational Definition of Criteria

Criteria	Operational Definition
Familiarity	Are you familiar with the KT, theory, model or framework?
Logical Consistency/Plausibility	Does the KT theory, model or framework, include meaningful, face-valid explanations of proposed relationships?
Degree of specificity	Does the KT theory, model, or framework include constructs that are comprehensive of implementation determinants or specific to a set of implementation determinants that could be applied to health technology reassessment (HTR)?
Accessibility	Would non-experts be able to understand, apply and operationalize the KT theory, model, or framework to HTR?
Ease of use	Can the KT theory, model, or framework be used easily?
HTR Suitability	Based on your responses to the previous criteria, is the KT theory, model, framework suitable for the dissemination and implementation of HTR outputs (increase use, decrease use or exit of the technology)?

Supplementary file 3: List of Excluded KT Theories, Models, and Frameworks and Reason of Exclusion from the Modified Delphi Process (n=20)

KT Theories, Models and Frameworks Excluded	Too vague	Not pragmatic	Passive	Too Specific
A conceptual framework for planning and improving evidence-based practices (Spencer, 2013)	X			
Interorganizational Relations Theory (Steckler, 2002)	X			
Self-Regulation Theory (Baumeister, 2011)		X		
Social Cognitive Theory (SCT) (Bandura, 1991)			X	
Social Ecology Model for Health Promotion (Stokols, 1992)	X			
Transtheoretical Model of Behaviour Change (Prochaska, 1997)			X	
LEAN transformation process (Lean Enterprise, 2011)		X		
NCHPAD (National Center on Health, Physical Activity and Disability) Knowledge, Adaptation, Translation and Scale-up (N-KTAS) Framework (Rimmer, 2016)				X
Community Connection model (Liddy, 2013)	X			
Model for accelerating improvement (Associates in Process Improvement Langley, 2009)	X			
Social marketing framework (National Excellence Collaborative, 2003)	X			
Community based KT framework (Campbell, 2010)	X			
Knowledge integration process (Glasgow, 2012)	X			
Precaution Adoption Process model (Weinstein, 2008)	X			
Social learning theory (Bandura, 1952)	X			
CAN-IMPLEMENT (Harrison, 2018)				X (guideline focused)
The translational model of the Black Dog Institute (Werner-Seidler, 2016)	X			
PRECEDE-PROCEED (Green, 2005)	X			

KT Theories, Models and Frameworks Excluded	Too vague	Not pragmatic	Passive	Too Specific
Community to community mentoring model (Liddy, 2013)	X			
Stage theory of organization change (Butterfoss, 2008)	X			